Badgerys Creek Industry Park

Air Quality Impact Assessment

ESR Developments

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Sydney NSW 2000
Prepared by:

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SLR Project No.: 610.032060.00003

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Making Sustainability Happen

Revision Record

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v1.1	4 May 2026	F Jafarigol	A Naghizadeh	Draft
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Basis of Report

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with ESR Developments (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

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Acronyms and Abbreviations

%	percent
>	greater than
<	less than
°C	degrees Celsius
µg	microgram
µg/m^3	microgram per cubic metre
µm	microns
AHD	Australian Height Datum
AMO	Aeronautical Meteorological Observer
Approved Methods	*Approved Methods for Modelling and Assessment of Air Pollutants in NSW (2022)*
Approved Methods for Sampling	*Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (2022)*
AQIA	Air Quality Impact Assessment
AQMS	Air Quality Monitoring Station
AWS	Automatic Weather Station
BoM	Bureau of Meteorology
CASANZ	Clean Air Society of Australia and New Zealand
CAQP	Certified Air Quality Professional
CAQMP	Construction Air Quality Management Plan
CO	carbon monoxide
CO_2	carbon dioxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCCEEW	Department of Climate Change, Energy, the Environment, and Water
DoP	Department of Planning
DPE	NSW Department of Planning and Environment (now Department of Planning, Housing and Infrastructure)
DPHI	Department of Planning, Housing and Infrastructure
EIS	Environmental Impact Statement
ENZ	environment and recreation zoned land
EPL	Environment Protection Licence
EV	electric vehicles
g	gram
GFA	gross floor area
GLA	gross lettable area
GMR	Greater Metropolitan Area
g/VKT	grams per vehicle kilometre travelled

ha	hectares
HDV	heavy duty vehicles
IPG	Ingham Property Group
km	kilometre
km/hr	kilometres per hour
kw	kilowatts
LDV	light duty vehicles
m	metres
mm	millimetres
m/s	metre per second
m^2	square metres
m^3	cubic metre
mg/m^3	milligram per cubic metre
NEPC	National Environment Protection Council
NEPM AAQ	National Environment Protection (Ambient Air Quality) Measure
NO	nitric oxide
NO_2	nitrogen dioxide
NO_X	oxides of nitrogen
NPI	National Pollutant Inventory (Australia)
NSW	New South Wales
NSW EPA	Environmental Protection Authority
O_3	ozone
OLM	Ozone Limited Method
PM_{10}	particulate matter with an equivalent aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an equivalent aerodynamic diameter of 2.5 microns or less
RAQST	Roadside Air Quality Screening Tool
POEO Act	Protection of the Environment Operations Act
pphm	parts per hundred million (10^8)
ppm	parts per million (10^6)
REF	Review of Environmental Factors
SEPP	State Environmental Planning Policy
SEARs	Secretary's Environmental Assessment Requirements
SLR	SLR Consulting Australia Pty Ltd
SO_2	sulphur dioxide
SSD	State Significant Development
SSDA	State Significant Development Application

TARP	Trigger Response Action Plan
TfNSW	Transport for New South Wales
TSP	total suspended particulate matter
VOCs	volatile organic compounds
US EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VKT	vehicle kilometres travelled
vpd	vehicles per day
WHO	World Health Organization

1.0 Introduction

ESR Developments (Australia) Pty Ltd (ESR) seeks to deliver a warehouse and distribution estate (Badgerys Creek Industry Park, the Project) at 85 Martin Road, Badgerys Creek (the Site). The Site is currently a small-scale bamboo plantation with several farm dams located on the western boundary. SLR Consulting Australia (SLR) was engaged by ESR to prepare an air quality impact assessment (AQIA) for the construction and operation of the Project to support the State Significant Development (SSD) application (SSD-74191717) for the Badgerys Creek Industry Park.

In December 2024, SLR prepared an Air Quality Impact Assessment (SLR Reference: 610.032060.00003-R01-v1.0-20241204) to address the Planning Secretary's Environmental Assessment Requirements (SEARs) issued on 27 August 2024. Subsequently, following the exhibition period in July 2025, the Department of Planning, Housing and Infrastructure (DPHI) requested additional information relating to the construction phase of the Project. The specific request concerning air quality impacts was as follows:

- *The Air Quality Impact Assessment (AQIA) currently includes a qualitative assessment of dust impacts on surrounding residential areas. However, given that dust emissions during earthworks and construction are classified as 'high', along with the proximity of sensitive receptors such as nearby residences and existing agricultural operations, a quantitative assessment of dust impacts is warranted. This will ensure that appropriate mitigation and management measures are effectively identified and implemented.*
- ***Recommendations:*** *An updated AQIA is required that includes a quantitative assessment of air quality impacts during construction*

To address the DPHI recommendations and the original SEARs, SLR has prepared this updated AQIA to include the requested quantitative assessment of construction impacts.

Specifically, this assessment addresses the air quality requirements outlined in the SEARs, as summarised in **Table 1**.

Table 1 Secretary's Environmental Assessment Requirements

Item	Description of Requirement	Section Reference (this report)
Key Issue	The SSD application is being prepared in accordance with the requirements of the Planning Secretary's Environmental Assessment Requirements (SEARs), issued by the Department of Planning, Housing and Infrastructure (DPHI) on 27 August 2024. With respect to air quality, the requirements of the SEARs are as follows: ***Air Quality and Odour -*** *an assessment of the potential air quality impacts of the development (construction and operation) on surrounding landowners, businesses and sensitive receptors, in accordance with relevant EPA guidelines, including details of proposed mitigation, management and monitoring measures."*	**Section 4.0** *(Construction AQA)* **Section 5.0** *(Operational AQA)* **Section 4.4** *(mitigation, management and monitoring measures)*

The assessment was prepared with consideration of the following policies and guidelines:

- Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (NSW EPA 2022)(the Approved Methods)
- Approved Methods for the Sampling and Analysis of Air Pollutants in (NSW EPA 2022a)
- *Protection of the Environment Operations Act 1997* (NSW Parliament, 1997)
- Protection of the Environment Operations (Clean Air) Regulation 2022 (NSW Parliament 2022)
- National Environment Protection (Ambient Air Quality) Measure (NEPC 2021)

The Approved Methods outlines the requirements for conducting an air quality impact assessment as follows (also indicated are the relevant sections of this report where the requirements are met):

- Description of local topographic features and sensitive receptor locations (**Section 3.1** and **Section 3.2** respectively)
- Establishment of air quality assessment criteria (**Section 2.6**)
- Analysis of climate and dispersion meteorology for the region (**Appendix B**)
- Description of existing air quality environment (**Section 3.5**)
- Compilation of a comprehensive emissions inventory for the proposed activities (**Section 4.2**)
- Completion of atmospheric dispersion modelling and analysis of results (**Section 4.3**)
- Preparation of an air quality impact assessment report comprising the above.

1.1 Site Location

The Project is proposed to be located at 85 Martin Road, Badgerys Creek, approximately 42 km west of Sydney CBD, 28 km west of Parramatta CBD and 7 km east of the Western Sydney International Airport, as presented in **Figure 1**.

Figure 1 Site Location

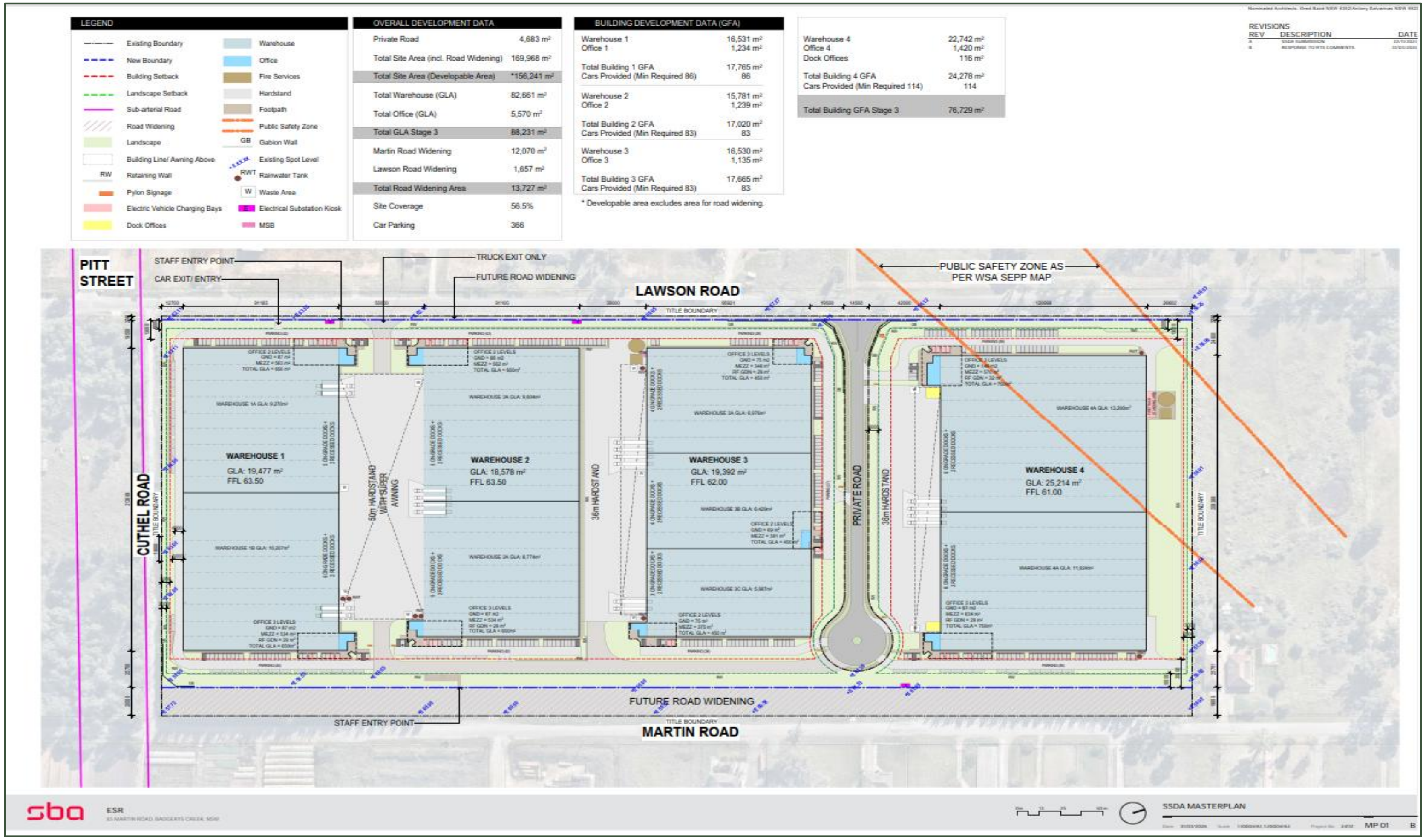
1.2 Overview of Report

Figure 2 shows the proposed layout of the Badgerys Creek Industry Park. The proposed development seeks to deliver a warehouse and distribution estate. The Project seeks a detailed staged approval for the construction of 90,895 m^2 of employment GLA across four warehouse and distribution buildings and a supporting ancillary office. The Project provides critical employment floor space to generate economic activity to support the growth of the Aerotropolis.

The Project encompasses the demolition, site preparation works and the construction of infrastructure, including an internal private road and temporary storm water basin. The Project is supported by landscaping in the form of perimeter planting surrounding the estate, vegetated communal areas, and street scape planting.

The Project involves the staged delivery of the estate across two stages to enable the provision of temporary stormwater basins before the delivery of the ultimate stormwater infrastructure by Sydney Water. The staged delivery of the estate comprises three warehouses in Stage 1 and one warehouse in Stage 2.

Figure 2 Masterplan



Source: SBA Architects 2026

1.3 Approach to Assessment

1.3.1 Construction Impact Assessment Methodology

The key potential air quality issue identified for the construction phase of the Site is particulate matter emissions associated with bulk earth works.

To assess potential peak impacts associated with construction stage emissions from the Site, a quantitative assessment in general accordance with the NSW EPA's *Approved Methods for Modelling and Assessment of Air Pollutants in NSW* publication (NSW EPA 2022) (hereafter referred to as the Approved Methods), has been prepared.

Section 2.1 of the Approved Methods outlines a two-tiered approach to Air Quality Impact Assessments (AQIA):

- Level 1, which is a basic screening using worst-case assumptions, and
- Level 2, a more detailed assessment with refined techniques and site-specific data.

If a Level 1 assessment shows that adverse impacts are unlikely, there is no need to proceed to Level 2.

For this assessment, considering the type of emissions associated with construction works, a Level 2 assessment using the TAPM/CALMET/CALPUFF modelling systems has been completed.

This assessment also considers cumulative impacts from surrounding construction activities. However, as construction activities are temporary and often consist of multiple stages, each with varying durations and emission levels, dust emissions from a single construction site tend to fluctuate significantly over time and are influenced by the type of work being done and weather conditions. This variability limits the accuracy that can be achieved using quantitative assessments and several conservative assumptions are required.

1.3.2 Operational Impact Assessment Methodology

The key potential air quality issue identified for the operational phase of the Site is emissions of combustion products associated with vehicle movements.

For this assessment, the Roadside Air Quality Screening Tool (RAQST) is employed. RAQST, developed by Transport for NSW (TfNSW), is a simplified version of a road vehicle emission model used for initial air quality impact screening. It employs worst-case scenarios to determine if a detailed Level 2 assessment is necessary, providing conservative predictions of incremental impacts. TfNSW recommends its use as a Level 1 equivalent for near-field ground-level pollutant concentration prediction from traffic.

1.4 Potential Emissions to Air

1.4.1 Construction Phase Emission Sources

The main air quality issues associated with construction works relate to emissions of fugitive dust. The potential for dust to be emitted during the construction works will be directly influenced by the nature of the activities being performed at any given time. Generally, the activities that are most likely to lead to short-term emissions of dust, include:

- Loading and unloading of materials.
- Grading
- Wheel-generated dust and combustion emissions from construction equipment.
- Wheel-generated dust from trucks travelling on unpaved surfaces.
- Wind erosion of exposed surfaces.

Temporary elevations in local dust levels are most likely to occur when construction activities are undertaken during periods of low rainfall and/or windy conditions. The impact of elevated dust emissions is dependent upon the potential for particulates to become and remain airborne before being deposited as dust or experienced as an ambient particulate concentration.

A number of environmental factors may affect the generation and dispersion of dust emissions, including:

- Wind direction - determines whether dust and suspended particles are transported in the direction of the sensitive receptors.
- Wind speed - determines the potential suspension and drift resistance of particles.
- Surface type - more erodible surface material types have an increased soil or dust erosion potential.
- Surface material moisture - increased surface material moisture reduces soil or dust erosion potential; and
- Rainfall or dew - rainfall or heavy dew that wets the surface of the soil reduces the risk of dust generation.

Where diesel-powered mobile machinery and vehicles are used, localised elevations in ambient concentrations of combustion-related pollutants may also occur, however, the potential risk of the relevant impact assessment criteria for these pollutants to be exceeded in surrounding sensitive areas is considered to be low. Fugitive dust emissions are generally considered to have the greatest potential to give rise to downwind air quality impacts at construction sites.

1.4.2 Operational Phase Emission Sources

During the operational phase, the main source of air emissions would be emissions of products of fuel combustion and particulate matter (from brake and tyre wear as well as re-entrainment of road dust) associated with the trucks and other vehicles entering and leaving or idling at the Site during loading/unloading operations. It is assumed that no refuelling, power generation or activities other than general warehousing and distribution would occur on Site.

Emissions associated with the combustion of fuel (diesel, petrol, etc.) in road vehicles will include carbon monoxide (CO), oxides of nitrogen (NO_x), particulate matter (PM_{10} and

$PM_{2.5}$), sulfur dioxide (SO_2) and volatile organic compounds (VOC_s). The exact rate and composition of air pollutant emissions from road vehicles is a function of several factors, including the type, size and age of the vehicles, the type of fuel combusted, the number and speed of vehicles and the road gradient.

1.4.3 Pollutants of Interest

As identified above, the key air pollutants of interest are considered to be particulate matter from construction works, wheel-generated dust and products of fuel combustion from operations.

The following sections outline the potential health and amenity issues associated with particulate matter and products of fuel combustion, while **Section 2.6** identifies the relevant air quality assessment criteria.

Particulate Matter

Airborne contaminants that can be inhaled directly into the lungs can be classified based on their physical properties as gases, vapours or particulate matter. In common usage, the terms “dust” and “particulates” are often used interchangeably. The health effects of particulate matter are strongly influenced by the size of the airborne particles. Smaller particles can penetrate further into the respiratory tract, with the smallest particles having a greater impact on human health as they penetrate the gas exchange areas of the lungs. Larger particles primarily cause nuisance associated with coarse particles settling on surfaces.

The term “particulate matter” refers to a category of airborne particles, typically less than 30 microns (µm) in diameter and ranging down to 0.1 µm and is called total suspended particulate (TSP). Particulate matter with an aerodynamic diameter of 10 microns or less is referred to as PM_{10}. The PM_{10} size fraction is sufficiently small to penetrate the large airways of the lungs, while $PM_{2.5}$ (2.5 microns or less) particulates are generally small enough to be drawn in and deposited into the deepest portions of the lungs. Potential adverse health impacts associated with exposure to PM_{10} and $PM_{2.5}$ include increased mortality from cardiovascular and respiratory diseases, chronic obstructive pulmonary disease and heart disease, and reduced lung capacity in asthmatic children.

Nuisance Dust

In addition, nuisance impacts need also to be considered, mainly in relation to deposited dust. Dust can cause nuisance by settling on surfaces and possessions, affecting visibility and contaminating tank water supplies. High rates of dust deposition can also adversely affect vegetation by blanketing leaf surfaces.

Dust falling onto plants can physically smother the leaves affecting photosynthesis, respiration and transpiration (Highways England 2019) Literature suggests that the most sensitive species appear to be affected by dust deposition at levels above 30 g/m^2/month, with most species unaffected until dust deposition rates are at levels considerably higher than this (Farmer 1993). This represents a level of impact approximately 7.5 times of the criteria adopted by this report and presented in **Section 2.6**.

Products of Combustion

Emissions associated with road traffic and the combustion of fossil fuels (diesel, petrol, AVGAS etc.) will include CO, NO_x, PM_{10}, $PM_{2.5}$, SO_2 and VOCs.

CO is an odourless, colourless gas formed from the incomplete burning of fuels in motor vehicles. It can be a common pollutant at the roadside and the highest concentrations are found at the kerbside with concentrations decreasing rapidly with increasing distance from the road. CO in urban areas results almost entirely from vehicle emissions and its spatial distribution follows that of traffic flow. The incomplete combustion of fuel in diesel powered vehicles can generate particulate in the form of black soot.

NO_x is a general term used to describe any mixture of nitrogen oxides formed during combustion. In atmospheric chemistry, NO_x generally refers to the total concentration of nitric oxide (NO) and nitrogen dioxide (NO_2). NO is a colourless and odourless gas that does not significantly affect human health. However, in the presence of oxygen, NO can be oxidised to NO_2 which can have significant health effects including damage to the respiratory tract and increased susceptibility to respiratory infections and asthma. NO will be converted to NO_2 soon after leaving the engine exhaust.

Engine exhausts can contain emissions of SO_2 due to impurities in the fuel. The sulfur content in diesel fuel has significantly reduced over the years ambient SO_2 concentrations in Australian cities are typically well below regulatory criteria.

Volatile organic compounds (VOCs) may be emitted as a result of the incomplete combustion of fuel. VOCs emissions are reducing significantly due to the improved combustion processes offered by modern engines.

2.0 Relevant Legislation, Policy and Guidance

The following relevant Air Quality Policy and Guidance documents have been referenced within this assessment and have been used to identify the relevant air quality criteria.

2.1 State Environmental Planning Policy (Precincts—Western Parkland City) 2021

Chapter 4 of the WPC SEPP relates to the Western Sydney Aerotropolis. The aims of this section of the WPC SEPP are as follows:

> (a) *to facilitate development in the Western Sydney Aerotropolis in accordance with the objectives and principles of the Western Sydney Aerotropolis Plan,*
>
> (b) *to promote sustainable, orderly and transformational development in the Western Sydney Aerotropolis,*
>
> (c) *to ensure development is compatible with the long-term growth and development of the Western Sydney Airport (including in relation to the operation of the Airport 24 hours a day) and other critical transport infrastructure,*
>
> (d) *to promote employment and world-class innovation and provide for residential development in suitable locations,*
>
> (e) *to recognise the physical and cultural connection of the local Aboriginal community to the land and to incorporate local Aboriginal knowledge, culture and tradition into development,*
>
> (f) *to preserve land for future infrastructure development,*
>
> (g) *to protect, maintain and enhance, and to minimise the impact of development on, trees and vegetation, soil quality and the health of waterways and to contribute to the conservation of biodiversity,*
>
> (h) *to recognise and protect the ecological and cultural value of Wianamatta–South Creek.*

There are no air quality specific development standards or provisions identified in Chapter 4 of the WPC SEPP, however the broader environmental protection context defined in (g) above is considered relevant to this AQA.

2.2 Western Sydney Aerotropolis Development Control Plan

The *Western Sydney Aerotropolis Development Control Plan (2022)* (WSA DCP) was amended on 11 July 2025. It supports the implementation of the Precinct Plan by providing controls to guide development across the initial precincts in the Aerotropolis. Appendix D of the DCP contains details regarding supporting documentation for development applications. Regarding air quality and odour, the following is stated:

> *D.5 Air Quality and Odour Assessment*
>
> - *An Air Quality and Odour Assessment is required for agricultural uses and some agricultural produce industries and industrial uses. It is also required for sensitive uses in the proximity of agricultural, rural, and industrial uses.*
> - *The assessment is to be undertaken by a suitably qualified Air Quality Professionals under the CAQP Scheme administered by the Clean Air Society of Australia and New Zealand (CASANZ) or Suitably qualified Environmental Practitioner under the CEnvP Scheme administered by the Environment Institute of Australia and New Zealand (EIANZ).*

This AQIA has been reviewed by Graeme Starke, a Technical Director at SLR and registered CAQP (CASANZ).

2.3 Protection of the Environment Operations (POEO) Act 1997 & Amendment Act 2011

The POEO Act (and Amendment Act 2011) is a key piece of environment protection legislation administered by the EPA group which enables and establishes instruments for setting environmental standards, goals, protocols and guidelines.

The following sections of the POEO Act are of general relevance to the Site:

- Section 126 of the POEO Act requires that materials (e.g. raw ingredients and waste storage/disposal at the Site) are managed in a proper and efficient manner to prevent air pollution (e.g. odour).
- Section 128 of the POEO Act states:
    1. The occupier of premises must not carry out any activity or operate any plant in or on the premises in such a manner to cause or permit the emission at any point specified in or determined in accordance with the regulation of air impurities in excess of [the standard of concentration and/or the rate] prescribed by the regulations in respect of any such activity or any such plant.
    2. Where neither such a standard nor rate has been so prescribed, the occupier of any premises must carry on activity, or operate any plant, in or on the premises by such practicable means as may be necessary to prevent or minimise air pollution.

2.4 Protection of the Environment Operations (Clean Air) Regulation 2022

The POEO (Clean Air) Regulation 2022 (the Regulation) is the core regulatory instrument for air quality issues in NSW. In relation to industry, the Regulation:

- sets maximum limits on emissions from activities and plants for a number of substances; and
- restricts the use of high sulphur liquid fuel.

2.5 NSW Environment Protection Authority Air Quality Policy and Guidance

The NSW Environmental Protection Agency (EPA) is the NSW regulatory authority responsible for air quality regulation and associated activities.

The NSW EPA document, Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (hereafter 'the Approved Methods') (NSW EPA 2022) , lists the statutory methods for modelling

and assessing air pollutants from stationary sources and specifies criteria that reflect the environmental outcomes adopted by the EPA. The Approved Methods are referred to in the POEO (Clean Air) Regulation 2022 for the assessment of impacts of air pollutants. The air quality criteria set out in the Approved Methods have been reproduced and discussed in **Section 2.6.**

2.6 Ambient Air Quality Criteria

State air quality guidelines specified by the NSW EPA for the pollutants identified in **Section 2.5** are published in the Approved Methods*.* The air quality impact assessment criteria listed in Section 7 of the Approved Methods have been established by NSW EPA to achieve appropriate environmental outcomes and to minimise risks to human health. They have been derived from a range of sources and are the defining ambient air quality criteria for NSW and are considered to be appropriate for use in this assessment.

The impact assessment criteria listed in the Approved Methods for relevant pollutants are shown in **Table 2**.

Table 2 NSW EPA Impact Assessment Criteria for Air Quality Assessment

Pollutant	Averaging Period	Ambient Air Quality Criterion	
		µg/m³	pphm
Total suspended particulate (TSP)	Annual	90	-
Particulate matter less than 10 microns (PM_{10})	24-Hour	50	-
	Annual	25	-
Particulate matter less than 2.5 microns ($PM_{2.5}$)	24-Hour	25	-
	Annual	8	-
Nitrogen dioxide (NO_2)	1-hour	164	8
	Annual	31	1.5
Carbon monoxide (CO)	15-minutes	100,000	8,700
	1-hour	30,000	2,500
	8-hour	10,000	900
Photochemical oxidants (as ozone)	8-hour	139	6.5
Sulfur dioxide (SO_2)	1-hour	215	10
	24-hour	57	2
Benzene	1-hour	29	0.9
Toluene	1-hour	360	9
Ethylbenzene	1-hour	8,000	180
Xylenes	1-hour	190	4

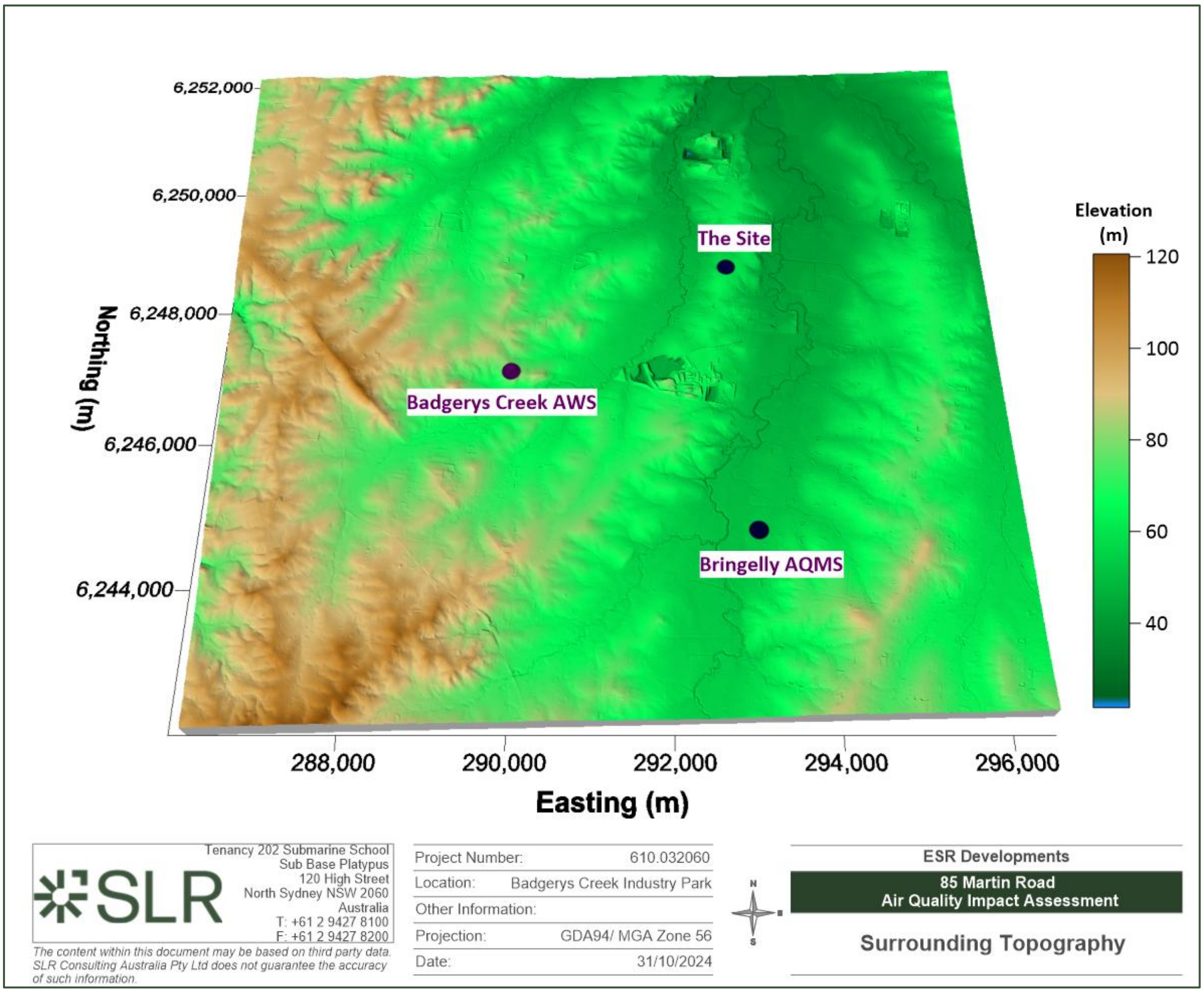
3.0 Local Environment

3.1 Topography

Local topography is important in air quality studies as local atmospheric dispersion can be influenced by night-time katabatic (downhill) drainage flows from elevated terrain or channelling effects in valleys or gullies.

The topography of the Site is relatively flat with an approximate elevation of 60 metres. A three-dimensional representation of the area surrounding the Site is presented in **Figure 3**. The location of the Badgerys Creek automatic weather station (AWS; refer to **Section 3.4**and Bringelly Air Quality Monitoring Station (AQMS; refer to **Section 3.5**) are also indicated.

Figure 3 Regional Topography

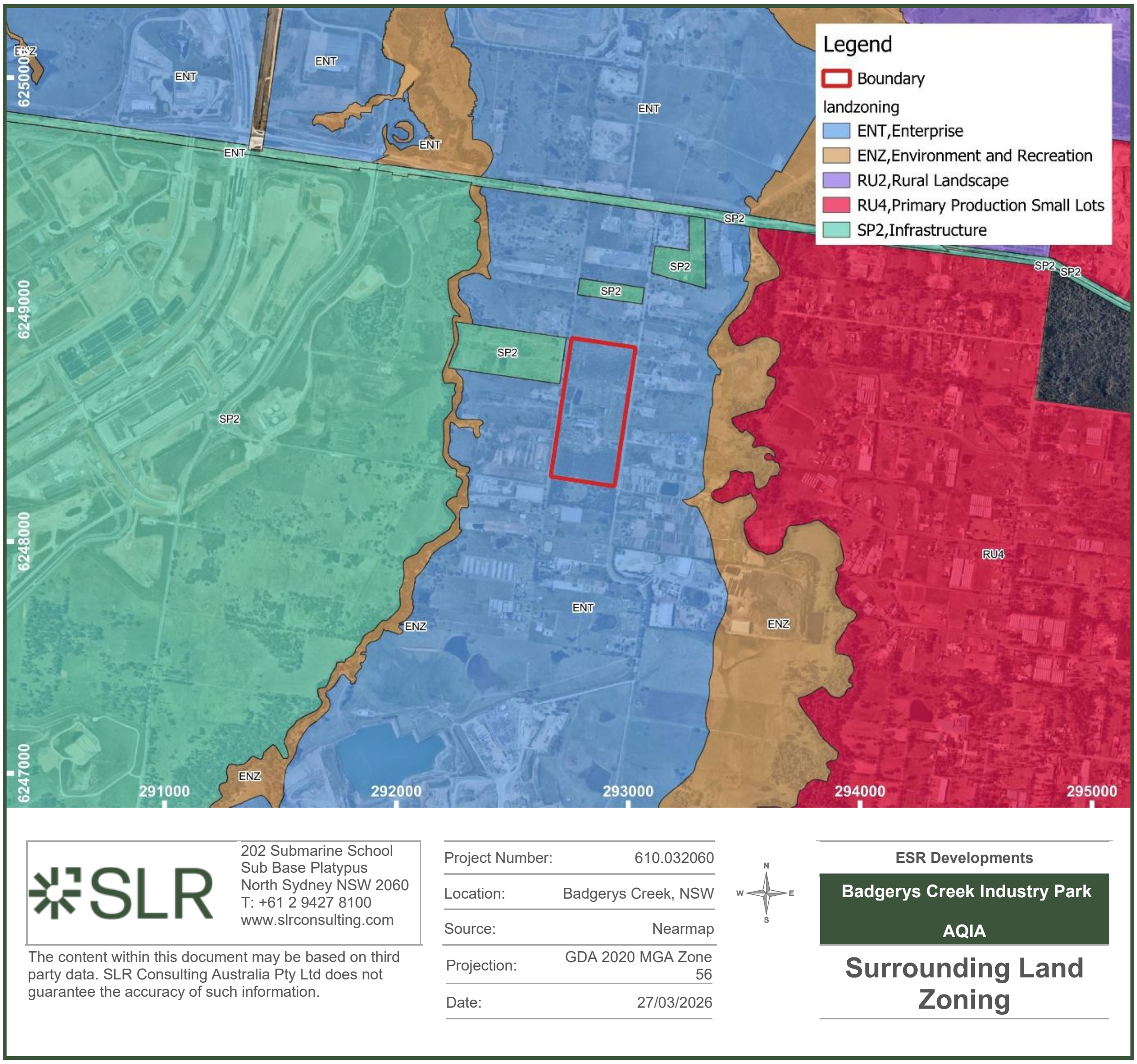


3.2 Surrounding Land Zoning and Sensitive Receptors

The Site is currently subject to the land use and development control provisions of the State Environmental Planning Policy (Precincts—Western Parkland City) 2021. **Figure 4** illustrates the surrounding land zoning. The Site and the immediately surrounding areas (apart from land to the northwest infrastructure, SP2) are zoned Enterprise (ENT). Further to the east and west there is land zoned for Environment and Recreation (ENZ) beyond which there is

Primary Production Small Lots (RU4) zoned land to the east and Infrastructure (SP2) zoned land to the west. The nearest residential receptors are located approximately 30 metres from the western Site boundary**.** However, these residential receptors are zoned for employment and will likely change over time.

Figure 4 Surrounding Land Zoning



3.3 Sensitive Receptors

Sensitive receptors are distributed in all directions surrounding the Site, as shown in **Figure 5**, with a relatively higher concentration to the northeast, and south of the Site. The nearest identified sensitive receptors are located approximately 30 m from the Site boundary (R6 to the north).

Table 3 summarises the locations and use of all receptors (R1–R27) included in the assessment and their corresponding distances to the nearest Site boundary.

The modelled receptor locations are intended to be representative of all sensitive receptor locations, whether discretely identified or not.

It is noted that Market Garden operations are also present in the vicinity of the Site. A receptor (R27) has been placed at the closest such area to quantify dust deposition on plants within this market garden.

Figure 5 Surrounding Receptors

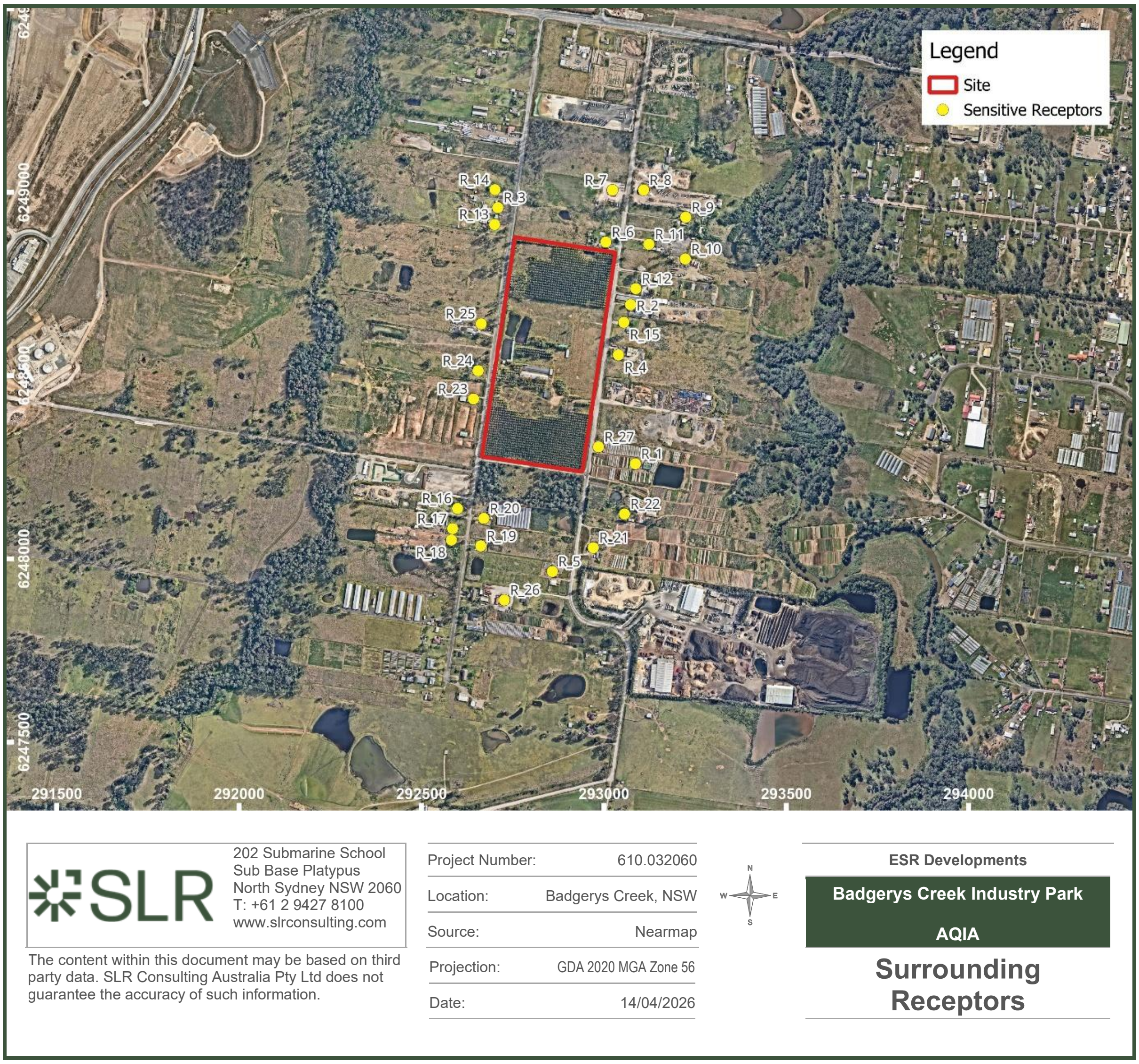


Table 3 Sensitive Receptor Locations

Map ID	Easting (m)	Northing (m)	Receptor Type	Distance from Closest Site Boundary (m)
R 1	293,086	6,248,259	Residential	140
R 2	293,073	6,248,693	Residential	60
R 3	292,709	6,248,958	Residential	90
R 4	293,040	6,248,556	Residential	50
R 5	292,859	6,247,965	Residential	280
R 6	293,005	6,248,864	Residential	30
R 7	293,023	6,249,006	Residential	170
R 8	293,109	6,249,006	Commercial/Industrial	190
R 9	293,224	6,248,932	Residential	210
R 10	293,223	6,248,818	Commercial/Industrial	190
R 11	293,123	6,248,858	Residential	100
R 12	293,087	6,248,737	Residential	70
R 13	292,700	6,248,912	Residential	60
R 14	292,701	6,249,007	Residential	140
R 15	293,055	6,248,645	Residential	50
R 16	292,599	6,248,137	Residential	160
R 17	292,585	6,248,082	Residential	210
R 18	292,582	6,248,051	Residential	240
R 19	292,662	6,248,035	Residential	240
R 20	292,671	6,248,110	Residential	160
R 21	292,971	6,248,030	Residential	200
R 22	293,056	6,248,122	Residential	170
R 23	292,642	6,248,436	Residential	40
R 24	292,655	6,248,513	Residential	50
R 25	292,663	6,248,641	Residential	60
R 26	292,727	6,247,887	Commercial/Industrial	370
R 27	292,985	6,248,305	Agricultural	30

3.4 Meteorological Conditions

The Bureau of Meteorology (BoM) maintains and publishes data from weather stations across Australia. The closest such station recording long term wind speed and wind direction data is the Badgerys Creek AWS (Station 67108, elevation 81 m AHD) located approximately 3.4 km southwest of the Site.

Badgerys Creek AWS, has data available from 1995 to the present for the following parameters:

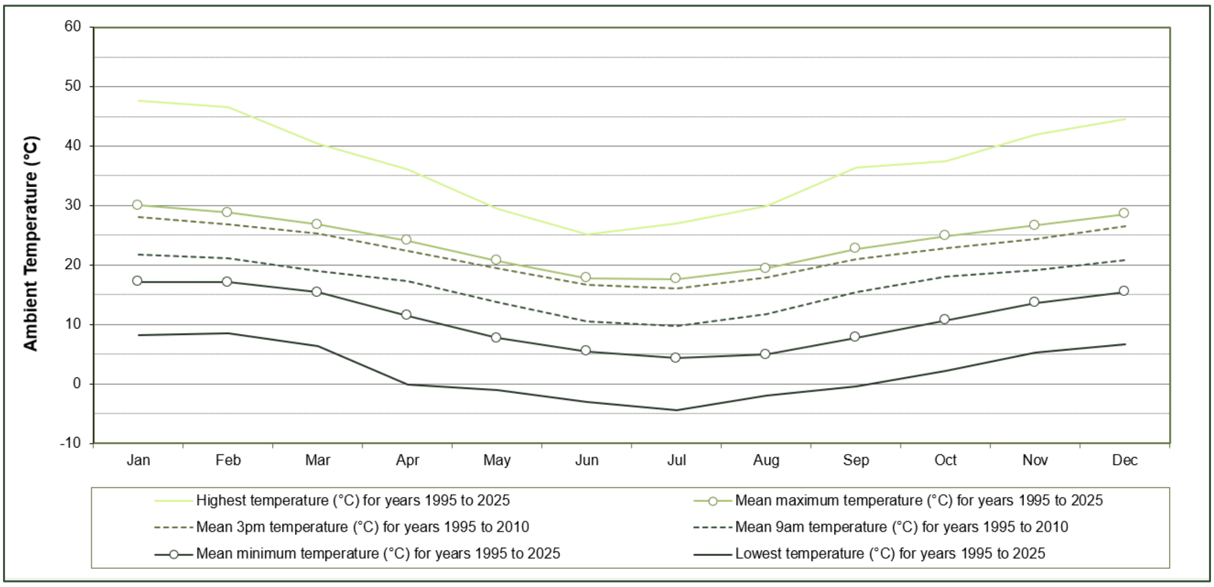
- temperature (°C)
- rainfall (mm)
- relative humidity (%)
- wind speed (m/s) and wind direction (degrees).

A review of the long-term data collected at this AWS is provided in the following sections.

3.4.1 Temperature

Temperature statistics for Badgerys Creek AWS between 1995 and 2025 are summarised in **Figure 6.** Mean maximum temperatures range from 17.6°C in winter to 30°C in summer, while mean minimum temperatures range from 4.3°C in winter to 17.2°C in summer.

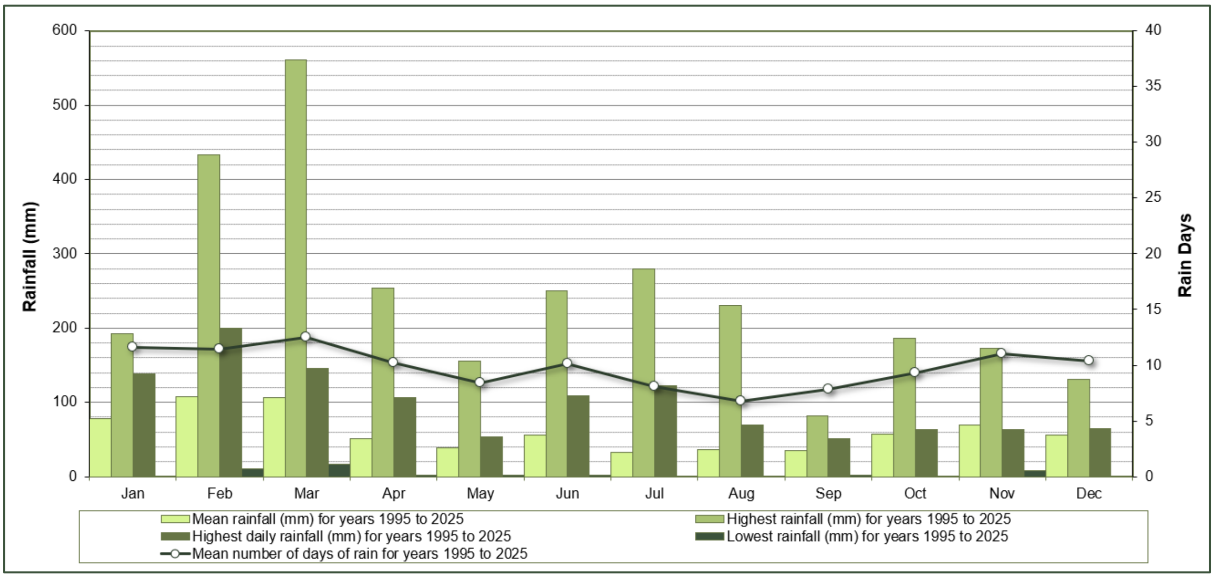
Figure 6 Temperature trends for Badgerys Creek AWS (1995 - 2025)



3.4.2 Rainfall

Rainfall statistics for Badgerys Creek AWS for the years 1995 to 2025 are summarised in **Figure 7**. The mean annual rainfall is 727.9 millimetres (mm). The average monthly rainfall is highest in summer, with the highest average daily rainfall of 107 mm in February and an average of 11.4 rainy days. The lowest monthly rainfall is 0 mm in December. The highest monthly rainfall recorded over the period examined was 561.4 mm, recorded in March 2022. The maximum daily rainfall of 200 mm was recorded on 10th February 2020.

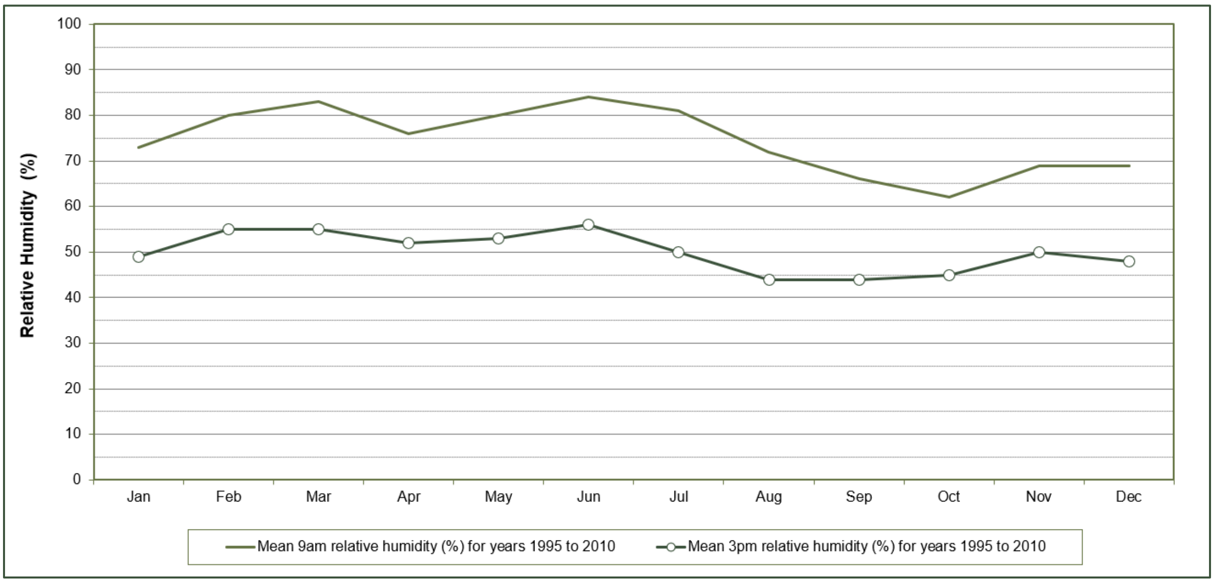
Figure 7 Monthly Rainfall Data for Badgerys Creek AWS (1995 – 2025)



3.4.3 Humidity

Available humidity statistics (9 am and 3 pm monthly averages) for Badgerys Creek AWS for the years 1995 to 2010 are summarised in **Figure 8**. Morning humidity levels range from an average of around 84% in June to around 62% in October. Afternoon humidity levels are lower, at around 56% in June and dropping to around 44% in August.

Figure 8 Humidity Data for Badgerys Creek AWS (1995 – 2010)



3.4.4 Wind

Local wind speed and direction influence the dispersion of air pollutants. Wind speed determines both the distance of downwind transport and the rate of dilution as a result of 'plume' stretching. Wind direction, and the variability in wind direction, determine the general path pollutants will follow and the extent of crosswind spreading. Surface roughness (characterised by features such as the topography of the land and the presence of buildings, structures and trees) will also influence dispersion.

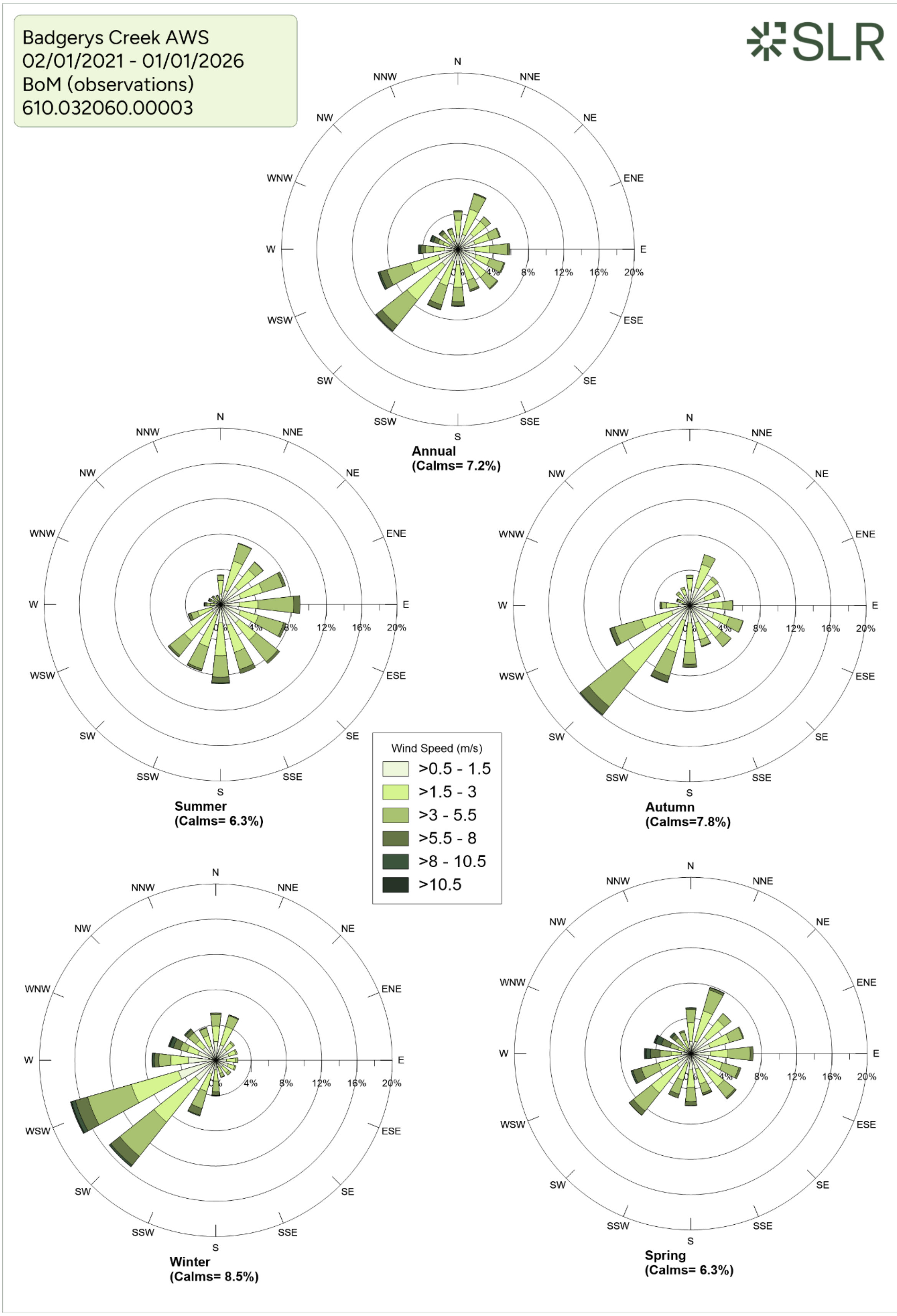
Annual and seasonal wind roses for years 2020-2024, compiled from data recorded by the Badgerys Creek AWS presented in **Figure 9**. Wind roses show the frequency of occurrence of winds by direction and strength. The bars correspond to the 16 compass points (degrees from North). The bar at the top of each wind rose diagram represents winds blowing from the north (i.e., northerly winds), and so on. The length of the bar represents the frequency of occurrence of winds from that direction, and the widths of the bar sections correspond to wind speed categories, the narrowest representing the lightest winds. Thus, it is possible to visualise how often winds of a certain direction and strength occur over a long period, either for all hours of the day or for periods during the day.

The annual wind rose for 2021–2025 indicates that winds predominantly originate from the southwest quadrant. Most wind speeds fall within the moderate range (1.5–5.5 m/s), with occasional stronger winds; however, speeds above 8 m/s remain relatively uncommon. Calm conditions occur 7.2% of the time, suggesting that although wind movement is generally steady, there are still periods of low air circulation.

The seasonal wind roses for 2021–2025 show the following patterns:

- Spring: Winds occur from all directions, with winds from the northwest being less frequent. Winds more commonly originate from the northeast during this season. Calm conditions occur approximately 6.3% of the time.
- Summer: Winds occur from all directions, with winds from the northwest being less frequent. During summer, winds more commonly come from the southeast. Calm conditions occur approximately 6.3% of the time.
- Autumn: Winds primarily blow from the southwest quadrant. Winds from the northwest are the least common during this season. Calm conditions occur around 7.8% of the time.
- Winter: Winds primarily blow from the southwest quadrant, with winds from the southeast being the least frequent. Calm conditions occur approximately 8.5% of the time.

Figure 9 Badgerys Creek Annual and Seasonal Wind Roses 2021-2025



3.5 Background Air Quality

Air quality monitoring is performed by the NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW) at a number of monitoring stations across NSW. The closest station to the Site is the Bringelly Air Quality Monitoring Station (AQMS), located approximately 3.7 km to the south of the Site (see **Section 3.1**). The following air pollutants are monitored at this station:

The following air pollutants are monitored at this station:

- NO, NO_2 & NO_X
- PM_{10}
- $PM_{2.5}$
- SO^2
- ozone (O_3).

A summary of the monitored pollutant concentrations for the last five years (2021-2025) is presented in **Table 4** and the data are presented graphically in **Figure 10** to **Figure 14**.

No TSP monitoring is conducted by the Bringelly AQMS. In the absence of any monitoring data for TSP, daily varying ambient TSP concentrations have been estimated from the PM_{10} concentrations recorded by the Bringelly AQMS using a PM_{10}/TSP ratio of 0.4 [1], which is typical for industrial areas in Australia. Therefore, for cumulative analysis purposes, the annual average background TSP concentration was estimated to be 37.5 µg/m^3.

No background dust deposition monitoring is conducted by the Bringelly AQMS. In the absence of suitably representative dust deposition monitoring data, a background dust deposition rate of 2 g/m^2/month has been assumed for this assessment, which is typical for residential/industrial areas in Australia. This results in the cumulative assessment criterion of 4 g/m^2/month being the defining criterion for emissions from the Site.

[1] This is conservative as when this ratio is determined from the total PM_{10} and TSP emissions to area in Sydney as detailed in the 2013 Calendar Year Air Emissions Inventory for the Greater Metropolitan Region in NSW, the ratio is 0.6, which would result in a concentration was estimated to be 25.0 µg/m^3. This includes the following sources of emissions: natural, commercial, domestic-commercial, industrial, off-road mobile, on-road mobile.

Table 4 Summary of Air Quality Monitoring Data at Bringelly AQMS (2021-2025)

Pollutant	PM_{10}		$PM_{2.5}$		NO_2		SO_2	
Averaging Period	**Maximum 24-hour**	**Annual**	**Maximum 24-hour**	**Annual**	**Maximum 1-hour**	**Annual**	**Maximum 1-hour**	**Maximum 24-hour**
Units	µg m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3
2021	69.0	15.3	57.4	7.2	49.2	7.1	25.7	5.7
2022	28.7	12.1	17.8	5.1	45.1	5.9	28.6	5.7
2023	53.2	16.2	45.4	7.0	51.3	6.2	25.7	8.6
2024	58.1	16.4	17.2	6.9	65.6	7.7	34.3	5.7
2025	77.3	16.9	19.9	6.7	53.3	7.6	100.1	8.6
Average	-	15.0	-	6.6	-	6.7	-	6.4
Criteria	**50**	**25**	**25**	**8**	**164**	**31**	**215**	**57**

Monitoring data from the Bringelly AQMS for the period 2021–2025 indicate that exceedances of the 24-hour average PM_{10} criterion occurred in all years except 2022. However, annual average PM_{10} concentrations remained below the relevant criterion in all years.

Exceedances of the 24-hour $PM_{2.5}$ criterion were recorded in 2021 and 2023. However, annual average $PM_{2.5}$ concentrations remained below the relevant criterion in all years.

A review of available compliance reports indicates that PM_{10} and $PM_{2.5}$ exceedances in earlier years were primarily associated with exceptional events, including bushfire smoke, dust storms, and hazard reduction burns (NSW DPIE 2020) (NSW DPE 2021). The elevated concentrations observed in 2021 and 2023 are consistent with the influence of regional dust and smoke events affecting western Sydney.

According to the NEPM compliance report for 2023, the single PM_{10} exceedance recorded in that year was classified as a non-exceptional event attributed to local dust (DCCEEW 2025).The NEPM compliance report for 2024 and 2025 had not been published at the time of this assessment; therefore, the cause of the PM_{10} exceedance recorded in 2024 and 2025 remains unknown.

Figure 10 Measured 24-Hour Average PM_{10} Concentrations at Bringelly AQMS (2021-2025)

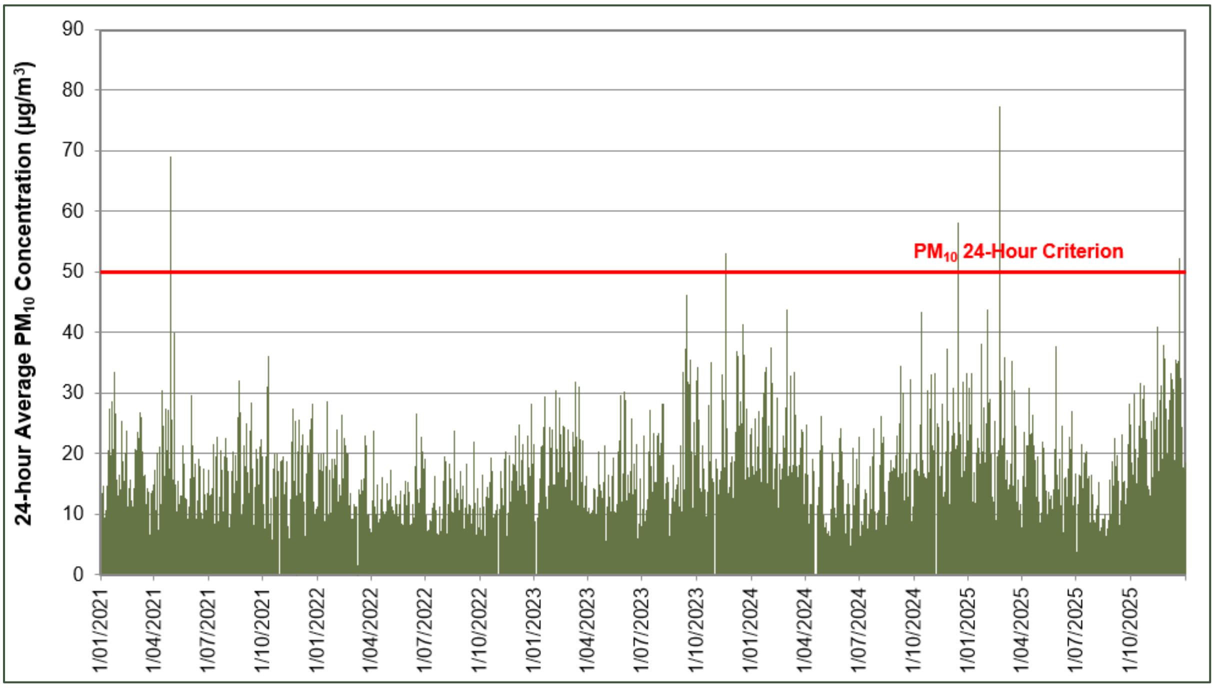


Figure 11 Measured 24-Hour Average $PM_{2.5}$ Concentrations at Bringelly AQMS (2021-2025)

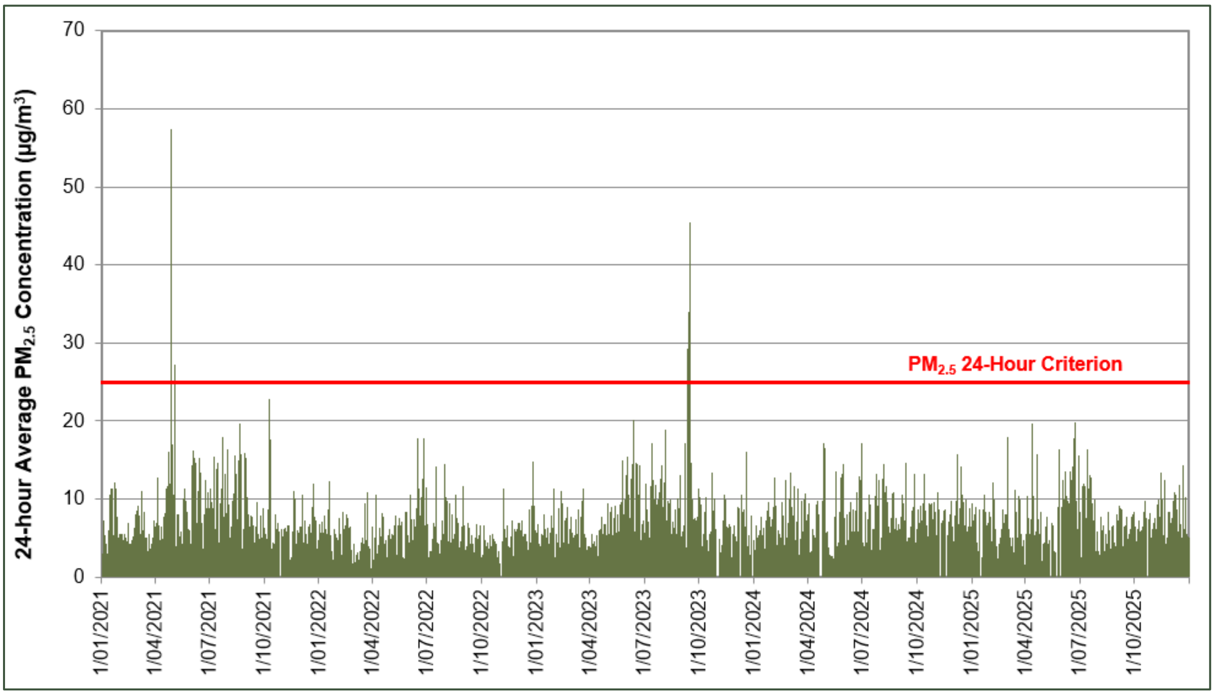


Figure 12 Measured 1-Hour Average NO_2 Concentrations at Bringelly AQMS (2021-2025)

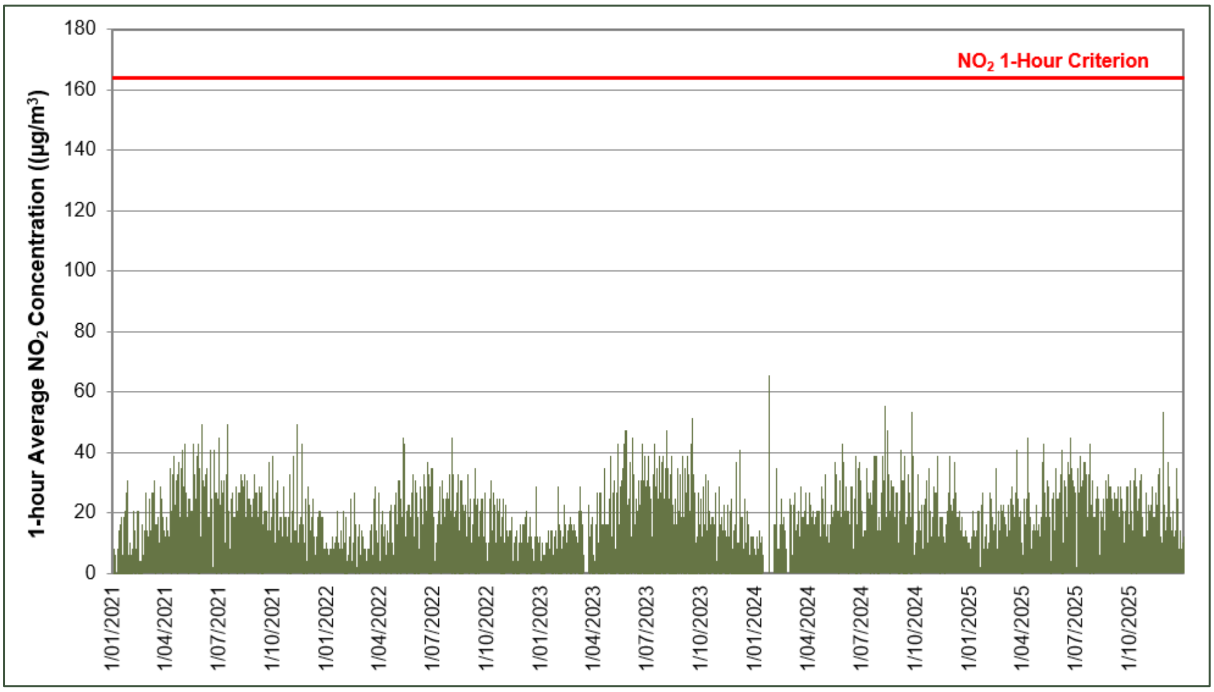


Figure 13 Measured 1-Hour Average SO_2 Concentrations at Bringelly AQMS (2021-2025)

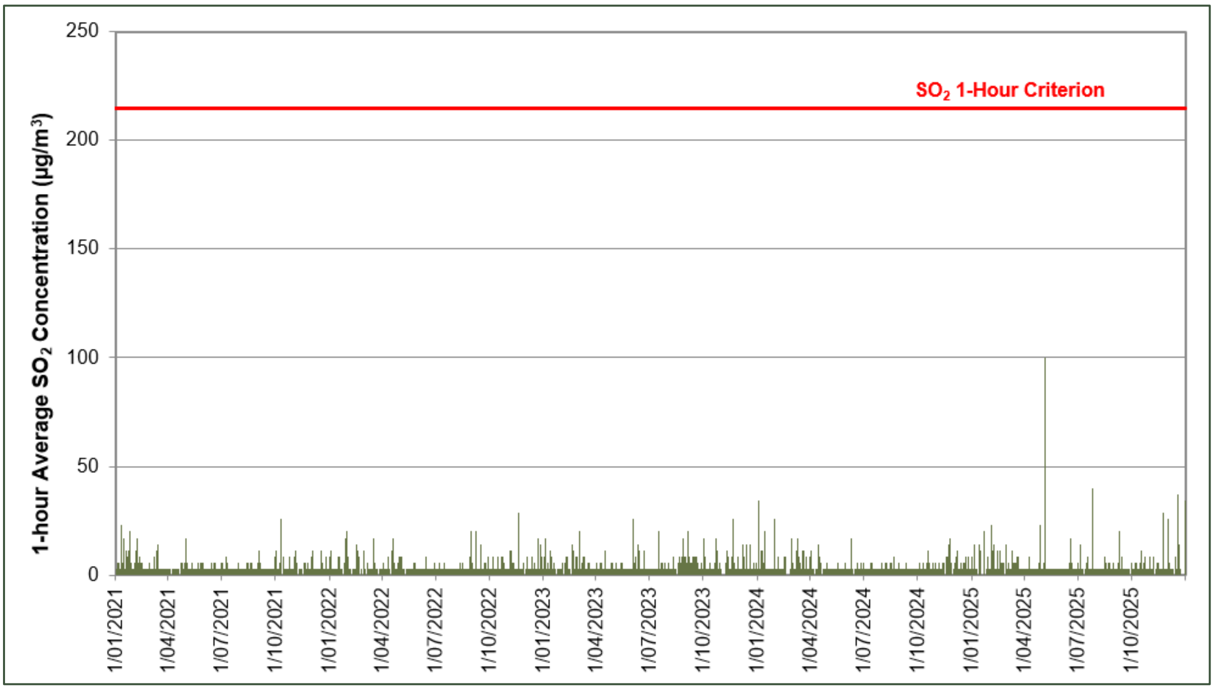
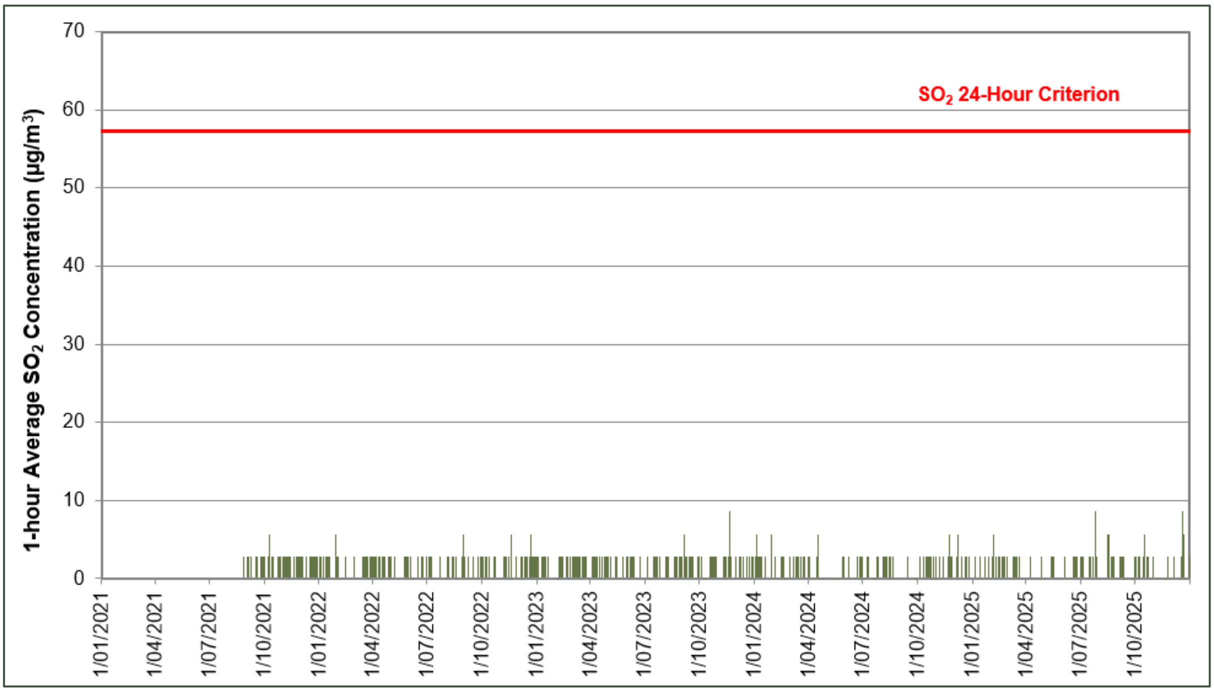


Figure 14 Measured 24-Hour Average SO_2 Concentrations at Bringelly AQMS (2021-2025)



4.0 Construction Air Quality Assessment

4.1 Assessment Methodology

The assessment of air emissions from the Site was performed quantitatively by air dispersion modelling in accordance with the Approved Methods. A detailed description of this methodology is provided in this section.

4.1.1 Dispersion Model

Emissions from the construction activities at the Site were modelled using the CALPUFF model, which is commonly used for air quality assessments in Australia. CALPUFF is a transport and dispersion model that ejects “puffs” of material emitted from modelled sources, simulating dispersion and transformation processes along the way (Scire et al., 2000). Commonly, input meteorological data are created by CALMET (discussed further in the following sub-sections). Temporal and spatial variations in the meteorological fields are explicitly incorporated in CALPUFF’s calculated distributions of puffs throughout a simulation period. The primary output files from CALPUFF contain hourly concentrations evaluated at selected receptor locations using CALPUFF’s post-processor, CALPOST.

4.1.2 Meteorological Modelling

Meteorological mechanisms govern the dispersion, transformation and eventual removal of pollutants from the atmosphere. The extent to which pollution will accumulate or disperse in the atmosphere is dependent on the degree of thermal and mechanical turbulence within the earth’s boundary layer. Dispersion comprises vertical and horizontal components of motion. The stability of the atmosphere and the depth of the surface-mixing layer define the vertical component. The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field. The wind speed determines both the distance of downwind transport and the rate of dilution as a result of plume ‘stretching’. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness. The wind direction and the variability in wind direction determine the general path pollutants will follow, and the extent of crosswind spreading.

Pollution concentration levels, therefore, fluctuate in response to changes in atmospheric stability, to concurrent variations in the mixing depth, and to shifts in the wind field (Oke 1988).

To adequately characterise the dispersion meteorology of the Site, information is needed on the prevailing wind regime, mixing height, atmospheric stability and other parameters such as ambient temperature, rainfall and relative humidity.

To determine a representative meteorological year for use in dispersion modelling, five years of meteorological data (2020-2024) from the closest meteorological monitoring station (i.e. Badgerys Creek AWS) were analysed against the five-year average meteorological conditions. Specifically, the following parameters were analysed:

- frequency and distribution of the predominant wind directions
- monthly average wind speeds observed
- monthly average temperatures.

Based on this analysis, it was concluded that the year 2021 was representative of the last five years of meteorological conditions experienced at the Site and hence the 2021 calendar year was adopted for use in this assessment. A summary of the analysis is presented in **Appendix A**.

Details of the meteorological modelling completed are provided below. A summary of the meteorological model domain details is provided in **Table 5.** Evaluation of the processed meteorological data is provided **Appendix B**.

4.1.2.1 TAPM

In order to calculate all required meteorological parameters required by the dispersion modelling process, meteorological modelling using The Air Pollution Model (TAPM, v 4.0.4) has been performed. TAPM, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is a prognostic model which may be used to predict three-dimensional meteorological data and air pollution concentrations.

TAPM model predicts wind speed and direction, temperature, pressure, water vapour, cloud, rainwater and turbulence. The program allows the user to generate synthetic observations by referencing databases (covering terrain, vegetation and soil type, sea surface temperature and synoptic scale meteorological analyses) which are subsequently used in the model input to generate site-specific hourly meteorological observations at user-defined levels within the atmosphere. A full description of TAPM is available in the model user manual (CSIRO, 2008).

TAPM model may assimilate actual local wind observations so that they can optionally be included in a model solution. However, given that TAPM is known to under-predict calm wind conditions, the wind speed and direction observations obtained from the nearest BoM and stations have also been used in the subsequent CALMET component of the modelling as described in **Section 4.1.3**.

The dispersion modelling requires twelve months of hourly timestep meteorological data. The Air Pollution Model (TAPM) was used to generate site-representative data for input into CALMET for further processing of the fine scale three-dimensional wind field data required for the CALPUFF dispersion model.

4.1.2.2 CALMET

In the simplest terms, CALMET is a meteorological model that develops hourly wind and other meteorological fields on a three-dimensional gridded modelling domain that are required as inputs to the CALPUFF dispersion model. Associated two dimensional fields such as mixing height, surface characteristics and dispersion properties are also included in the file produced by CALMET. The interpolated wind field is then modified within the model to account for the influences of topography, sea breeze, as well as differential heating and surface roughness associated with different land uses across the modelling domain. These modifications are applied to the winds at each grid point to develop a final wind field. The final hourly varying wind field thus reflects the influences of local topography and land uses.

A full description of the CALMET/CALPUFF model is available in the CALPUFF manual (SRC 2011).

The CALMET domain was modelled with a resolution of 50 m. The TAPM-generated 3-dimensional meteorological data (1 km resolution) was used as the ‘initial guess’ wind field and the local topography and available surface weather observations in the area were used to refine the wind field predetermined by TAPM.

Table 5 TAPM and CALMET Modelling Domain Details

Model and Domain Settings	Details	Model and Domain Settings	Details
TAPM		**CALMET**	
5 nested grids	25 x 25 x 35 grid points	Domain size	12.5 km x 12.5 km
Grid point resolutions	30 km, 10 km, 3 km, 1 km, 300 m	Receptor grid	50 m resolution
Domain origin centre point	E: 295,164 N: 6,253,975 Zone: 56H	Domain origin southwest corner	E: 286,250 N: 6,241,750 Zone: 56H
Period	31/12/2020 to 01/01/2022	Period	31/12/2020 to 01/01/2022
Modelled with wind assimilation data for Badgerys Creek AWS and Horsley Park Equestrian Centre AWS. Further details on model settings can be provided as required.		Initial guess field	3D output from TAPM

4.1.3 Dispersion Model Configuration

CALPUFF was used for the dispersion modelling and is widely used in Australia as a suitable model for a range of applications and conditions, including odour modelling assessments.

As with any air dispersion model, CALPUFF requires inputs in three major areas:

- emission rates and source details
- meteorology
- terrain and surface details, as well as specification of specific receptor locations.

A summary of the model details is provided in **Table 6**.

Table 6 CALPUFF Domain Details and Model Settings

Item	Details
Domain details	50 m resolution for 12.5 km by 12.5 km domain
Receptor details	50 m resolution gridded receptors and 27 discrete receptors
Emissions data	Varys by emission source. Refer to **Section 4.2** and **Appendix C**for details.
Further details on model settings can be provided as required.	

Emissions from all construction activities were represented by a series of volume sources and area source were used in the model for all wind erosion sources. The estimated particulate emissions were modelled as:

- Fine Particulates (FP < 2.5 µm);
- Coarse Matter (2.5 µm<CM<10 µm); and
- the Rest (RE>10 µm).

These parameters were then grouped using CALPOST to predict $PM_{2.5}$, PM_{10} and TSP concentrations at surrounding receptor locations. This approach provides the most realistic treatment of the differing size fractions, with the lighter, finer particulate matter being dispersed further than the heavier size fraction which settles out of the air more rapidly.

4.1.4 Adopted Background for this Assessment

The purpose of assessing background air quality is to determine the concentrations of air pollutants currently experienced at surrounding receptors, with the predicted concentrations from the Site emissions added to these background concentrations to identify the likely future cumulative air quality impacts.

For the purposes of assessing potential cumulative off-site air quality impacts, an estimation of ambient air quality concentrations is required. In accordance with the Approved Methods, the background data used in this AQIA is based on the same year as the meteorological year used in the modelling (i.e. 2021).

The representative background ambient air quality concentrations adopted for use in this assessment are summarised in **Table 7**.

Table 7 Adopted Background Data

Pollutant	Averaging Period	Regional Background	Notes
TSP	Annual	Daily varying	Calculated from PM_{10} concentrations at Bringelly AQMS during 2021, with a PM_{10}/TSP ratio of 0.4
PM_{10}	24-hour	Daily varying	As monitored at Bringelly AQMS during 2021
	Annual	15.3 µg/ m³	As monitored at Bringelly AQMS during 2021
$PM_{2.5}$	24-hour	Daily varying	As monitored at Bringelly AQMS during 2021
	Annual	7.2 µg/ m³	As monitored at Bringelly AQMS during 2021
Deposited dust	Annual	2 g/m²/month	Estimated. Not monitored at Bringelly AQMS

4.1.4.1 Accuracy of Modelling

All atmospheric dispersion models, including CALPUFF, represent a simplification of the many complex processes involved in the dispersion of pollutants in the atmosphere. To obtain good quality results, it is important that the most appropriate model is used and the quality of the input data (meteorological, terrain, source characteristics) is adequate.

The main sources of uncertainty in dispersion models, and their effects, are discussed below:

- Oversimplification of physics: This can lead to both under-prediction and over-prediction of ground-level pollutant concentrations. Uncertainties are greater in Gaussian plume models as they do not include the effects of non-steady-state meteorology (i.e., spatially- and temporally varying meteorology).
- Uncertainties in emission rates: Ground-level concentrations are proportional to the pollutant emission rate. In addition, most modelling studies assume constant worst-case emission levels or are based on the results of a small number of stack tests, operations (and thus emissions) are often quite variable. Accurate measurement of emission rates and source parameters requires continuous monitoring.

- Uncertainties in wind direction and wind speed: Wind direction affects the direction of plume travel, while wind speed affects plume rise and dilution of the plume. Uncertainties in these parameters can result in errors in the predicted distance from the source of the plume impact, and the magnitude of that impact. In addition, aloft wind directions commonly differ from surface wind directions. The preference to use rugged meteorological instruments to reduce maintenance requirements also means that light winds are often not well characterised.
- Uncertainties in mixing height: If the plume elevation reaches 80% or more of the mixing height, more interaction will occur, and it becomes increasingly important to properly characterise the depth of the mixed layer as well as the strength of the upper air inversion.
- Uncertainties in temperature: Ambient temperature affects plume buoyancy, so inaccuracies in the temperature data can result in potential errors in the predicted distance from the source of the plume impact, and the magnitude of that impact.
- Uncertainties in stability estimates: Gaussian plume models use estimates of stability class, and 3D models use explicit vertical profiles of temperature and wind (which are used directly or indirectly to estimate stability class for Gaussian models). In either case, uncertainties in these parameters can cause either under-prediction or over-prediction of ground level concentrations. For example, if an error is made of one stability class, then the computed concentrations can be off by 50% or more.

The US EPA makes the following statement in its Modelling Guideline (US EPA 2005) on the relative accuracy of models:

"Models are more reliable for estimating longer time-averaged concentrations than for estimating short-term concentrations at specific locations; and the models are reasonably reliable in estimating the magnitude of highest concentrations occurring sometime, somewhere within an area. For example, errors in highest estimated concentrations of ±10 to 40% are found to be typical, i.e., certainly well within the often-quoted factor-of-two accuracy that has long been recognised for these models. However, estimates of concentrations that occur at a specific time and site are poorly correlated with actually observed concentrations and are much less reliable."

4.2 Emission Estimation

4.2.1 Project Emissions

Dust emissions from construction activities are expected to temporarily affect local air quality in surrounding areas. These emissions are generated by typical activities such as earthworks, material handling, and the movement of construction vehicles.

At the time of this assessment, detailed construction methodologies and activity-level information were not available. Accordingly, emissions have been estimated using an area-based emission factor derived from comparable large-scale construction projects in the immediate vicinity that employ similar mitigation measures.

Construction will occur in stages across a total developable area of approximately 15.6 ha. For the purpose of providing a conservative assessment, it has been assumed that up to 75% of the developable area is under active construction at any one time, resulting in a maximum active disturbed area of approximately 11.7 hectares.

To estimate emissions for the 11.7 hectare active area, a review of detailed emission inventories prepared for four comparable local projects was undertaken (125-175 Lawson Road, 225-245 Martin Road, and two confidential local projects). The total estimated emissions and active areas for these benchmark projects were reviewed to calculate an average area-based emission factor (kg/ha/year) for both construction earthworks and wind erosion. A summary of the derived emission factors is presented in **Table 8**.

Table 8 Summary of Emission Data Used to Derive Emission Factor

Activity	Pollutant	125-175 Lawson Road (kg/y)	Confidential Project A (kg/y)	Confidential Project B (kg/y)	225-245 Martin Road (kg/y)	Derived Emission Factor ($g/m^2/s$)
Construction Activities	TSP	4,236	1,108	10,447	4,790	3.56E-05
	PM_{10}	1,138	371	3,248	1,432	1.07E-05
	$PM_{2.5}$	320	37	325	275	1.66E-06
Wind Erosion	TSP	1,752	3,504	3,504	1,752	8.33E-06
	PM_{10}	876	1,752	1,752	876	4.17E-06
	$PM_{2.5}$	88	263	263	131	5.90E-07
Disturbed Site Area (ha)	-	7	27	26	88	-

These derived emission factors were then applied to the 11.7 ha active area of the Site to calculate the total annual emissions, which were subsequently converted to grams per second (g/s) for input into the dispersion model. The estimated site emission rates are presented in **Table 9**.

Table 9 Summary of Emission Rates

Activity	Area (ha)	TSP emission (kg/year)	PM_{10} emission (kg/year)	$PM_{2.5}$ emission (kg/year)
Construction	11.7	60,296	18,133	2,804
Wind Erosion	11.7	30,795	15,398	2,181

While there are inherent uncertainties associated with estimating emissions in the absence of detailed construction plant and equipment data, the adopted area-based approach is intentionally conservative. Specifically, the emission estimates:

- Do not account for the full benefits of several proposed mitigation measures, such as reduced vehicle speeds and the cessation or reduction of activities during adverse meteorological conditions or elevated background air pollution events;
- Likely underestimate the suppressive effect of rainfall on dust emissions; and
- Assume construction activities occur for 11 hours per day, 365 days per year, with wind erosion modelled 24 hours a day, 365 days per year.

4.2.2 Surrounding Sources

Surrounding the proposed development, there are other existing or likely future developments that may give rise to potential cumulative impacts during construction These developments are reviewed in **Table 10.** Sources included in the assessment are shown in **Figure 15**.

To estimate emissions from site activities at these surrounding developments (Surrounding Sources), a two-tiered approach was adopted:

1. Where a publicly available Environmental Impact Statement (EIS) containing a detailed construction air quality assessment existed, the specific TSP, PM_{10}, and $PM_{2.5}$ emission rates were adopted directly from those studies.
2. Where no detailed air quality assessment was publicly available, emissions were estimated using the same methodology applied to the Site. The derived benchmark construction emission factors (calculated in **Section 4.2.1**) were applied to the estimated active construction area of the surrounding development.

The resulting estimated emissions for all surrounding sources are detailed in **Table 11**.

To ensure a conservative cumulative assessment, the modelling assumed that for all Surrounding Sources:

- All proposed developments would be under construction simultaneously;
- 50% of the developable land for each surrounding site is actively under construction at any given time;
- Construction occurs 365 days a year, for 11 hours per day (7:00 am to 6:00 pm), with wind erosion modelled continuously; and
- Mitigation controls achieve a similar reduction efficiency to those applied at the Site (see **Section 4.4**).

Table 10 Surrounding Likely Future Development

Development	Status	Consideration	Included in Cumulative Assessment?	Construction Details
Part 5 Activity – Martin Road / Elizabeth Drive intersection upgrades	Approved	This development is located within 1km from the Site, cumulative impacts are considered possible.	Yes	The project area for the intersection upgrade works under the Part 5 Approvals is approximately 41,500 m^2 [a].
SSD 97711727 225-245 Martin Road, Bradfield Bulk Earthworks (Bulk Earthworks)	Exhibition	This development is located within 1km from the Site, cumulative impacts are considered possible.	Yes	The total project area is approximately 878,620 m^2 [b]. An assessment of air quality impacts is publicly available for review and comment.
SSD-65529236 EMKC3 Industrial Development (230 Martin Road, Badgerys Creek NSW 2555)	Prepare EIS	This development is located within 1km from the Site, cumulative impacts are considered possible.	Yes	The site area is approximately 245,000 m^2, however the total project area is approximately 79,000 m^2 c. An assessment of air quality impacts is not publicly available at this stage.
SSD-81662708 Cross Link Industrial Estate (125; 145-175 Lawson Road, Badgerys Creek)	Exhibition	This development is located within 1km from the Site, cumulative impacts are considered possible.	Yes	The total project area is approximately 80,500 m^2 [d]. An assessment of air quality impacts is publicly available for review and comment.
SSD-19618251 Elizabeth Enterprise Precinct - Stage 1	Approved	This development is located within 1km from the Site, cumulative impacts are considered possible.	Yes	The total project area is approximately 272,000 m^2.

Development	Status	Consideration	Included in Cumulative Assessment?	Construction Details
(1669-1723 Elizabeth Drive, Badgerys Creek)				An AQIA was completed by SLR in August 2025[e].
SSD-99079487 Elizabeth Enterprise Precinct - Stage 2 (1669-1723 Elizabeth Drive, Badgerys Creek)	Prepare EIS	This development is located within 2km from the Site, cumulative impacts are considered possible.		The total project area is approximately 430,715 m^2 [e]. An assessment of air quality impacts is not publicly available at this stage.
SSD-76913969 Aldi Automated Distribution Centre (475 Badgerys Creek Road, Bradfield) IPG - Stage 2	Approved	This development is located within 2km from the Site, cumulative impacts are considered possible. However, Aldi Automated Distribution Centre is contained within the IPG Badgerys Creek Road site. The IPG Badgerys Creek Road Master Plan was approved in July 2025 (the IPG Master Plan). The staging of the IPG Master Plan has been reviewed for timing and found that IPG Stage 2 is likely to overlap with the Site, and due to that, Stage 2 of the IPG Master Plan has been included.	Yes – IPG Master Plan Stage 2	The total project area of IPG Master Plan Stage 2 is approximately 339,000 m^2 [f]. An AQIA was completed by SLR in August 2027[f], however, it was not a quantitative assessment. No quantitative assessment of air quality impacts is publicly available at this stage.
SSD-82437463 30-40 Martin Road, Badgerys Creek Waste Transfer Station, Badgerys Creek	Prepare EIS	This development is located within 1km from the Site, cumulative impacts are considered possible.	Yes	The site area is approximately 44,500 m^2 however, the total project area is approximately 25,000 m^2 [g]. An assessment of air quality impacts is not publicly available at this stage.

Notes:

a – Client information

b – Source: https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=SSD-97711727%2120260326T044354.676%20GMT, Accessed 1 May 2026.

Development	Status	Consideration	Included in Cumulative Assessment?	Construction Details
c – Source: https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=SSD-65529236%2120231206T221219.036%20GMT, Accessed 1 May 2026. d – Source: https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=PDA-81613458%2120250327T235757.337%20GMT, Accessed 1 May 2026. e – Source: https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=EXH-83152958%2120251013T041327.831%20GMT, Accessed 1 May 2026. f – Source: https://shared-drupal-s3fs.s3.ap-southeast-2.amazonaws.com/master-test/s3fs-public/dpe-public/documents/NSW%2BPlanning%2BPortal%2Bexhibitions%2B/Badgerys%2BCreek%2BRoad%2BMaster%2BPlan/Appendix+AA_Civil+Engineering+Drawings_for+Master+Plan+(1).pdf, Accessed 1 May 2026. g – Measured from plans included in request for SEARS, source: https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=SSD-82437463%2120250411T065901.441%20GMT, Accessed 1 May 2026.				

Table 11 Summary of Emission Rates used to Assess Cumulative Impacts

Activity	Address of Construction	Area Modelled (m^2)	TSP emissions (g/s)	PM_{10} emissions (g/s)	$PM_{2.5}$ emissions (g/s)
Construction	Martin Road/Elizabeth Drive Intersection	41,469	0.68	0.20	0.03
	225-245 Martin Road, Bradfield Bulk Earthworks	878,620	13.35	3.99	0.77
	230 Martin Road, Badgerys Creek NSW 2555	59,137	1.29	0.39	0.06
	125; 145-175 Lawson Road, Badgerys Creek	60,365	0.94	0.25	0.07
	SEED - Stage 1	135,914	2.42	0.73	0.07
	SEED - Stage 2	215,358	3.51	1.06	0.16
	IPG - Stage 2	169,500	2.77	0.83	0.13
	30-40 Martin Road, Badgerys Creek	22,285	0.36	0.11	0.02
Wind Erosion	Martin Road/Elizabeth Drive Intersection	41,469	0.35	0.17	0.02
	225-245 Martin Road, Bradfield Bulk Earthworks	878,620	4.88	2.44	0.37
	230 Martin Road, Badgerys Creek NSW 2555	59,137	0.66	0.33	0.05
	125; 145-175 Lawson Road, Badgerys Creek	60,365	0.39	0.19	0.02
	SEED - Stage 1	135,914	3.02	1.51	0.23
	SEED - Stage 2	215,358	1.79	0.90	0.13
	IPG - Stage 2	169,500	1.41	0.71	0.10
	30-40 Martin Road, Badgerys Creek	22,285	0.19	0.09	0.01

Figure 15 Location of Modelled Surrounding Sources

SLR
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Sub Base Platypus
North Sydney NSW 2060
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Project Number:	610.032060
Location:	Badgerys Creek, NSW
Source:	Nearmap
Projection:	GDA 2020 MGA Zone 56
Date:	01/05/2026

N W E S

ESR Developments
Badgerys Creek Industry Park
AQIA
Surrounding Sources

4.3 Assessment of Air Quality Impacts

The sections below present a summary of the air quality impacts predicted by the modelling at the sensitive receptors modelled.

Isopleth plots showing the incremental impact predicted due to the emissions from the Site for each pollutant are presented in **Appendix D**. These plots do not represent the dispersion pattern for any individual time period but rather illustrate the maximum concentration that was predicted to occur at each model calculation point given the range of meteorological conditions occurring over the 2021 modelling period.

4.3.1 Particles as $PM_{2.5}$

4.3.1.1 Maximum 24-Hour Average $PM_{2.5}$ Concentrations

Table 12 summarises the incremental and cumulative 24-hour average $PM_{2.5}$ impacts for the 10 most affected discrete receptor locations modelled. These locations were selected based on the maximum 24-hour $PM_{2.5}$ increments predicted by the modelling due to the proposed bulk earthworks.

A contemporaneous analysis was conducted to assess cumulative impacts against the relevant air quality criteria. This involved combining the incremental 24-hour $PM_{2.5}$ impacts from the surrounding sources identified in **Section 4.2.2** and the daily varying background concentrations recorded at the Bringelly AQMS.

Cumulative 24-hour average $PM_{2.5}$ concentrations are predicted to exceed the 25 µg/m³ criterion at 13 of the 27 modelled receptors. These results are heavily influenced by elevated background levels. It is noted that the background data for the 2021 meteorological year already included three exceedances of the criterion, independent of the Site's activities.

Receptor R4, identified as having the highest incremental impact and the highest cumulative concentration, is predicted to experience 2 additional exceedance days when considering both Site activities and surrounding sources. The recommended trigger action response plan (TARP) and monitoring outlined in **Section 4.4.1** could significantly reduce the likelihood of additional exceedances.

A detailed daily analysis of Receptor R4 is presented in **Figure 16** and **Figure 17**. The results indicate that incremental contributions from the Site are generally higher during the cooler months, with increased variability observed from late autumn through winter. **Figure 17** demonstrates that, for the vast majority of days throughout the year, cumulative 24-hour average $PM_{2.5}$ concentrations remain well below the NSW EPA impact assessment criterion of 25 µg/m³ at the most impacted receptor. Isolated short-term exceedances are evident, most notably during early winter, and are driven predominantly by regional background rather than the Site increment itself.

Isopleths showing dispersion patterns across the modelling domain are provided in **Appendix D**.

Table 12 Top 10 Highest $PM_{2.5}$ Incremental Impact Receptors - 24-Hour $PM_{2.5}$ Impact

Receptor ID	Maximum 24-Hour Average $PM_{2.5}$ Concentrations (µg/m³)		Additional Exceedances[2] due to Site Activities & Surrounding Sources	Additional Exceedances[2] due to Site Activities
	Incremental Impact	Cumulative Impact [1]		
R4	8.6	58.5	1	1
R23	7.7	58.4	1	1
R15	8.1	60.2	2	2
R24	8.5	58.5	1	1
R27	7.9	60.2	0	0
R2	7.0	58.4	1	1
R25	7.1	59.9	0	0
R12	6.6	58.3	1	1
R20	8.1	58.1	1	1
R19	5.2	58.3	0	0
Criterion		**25**		

1 – Cumulative impact includes: Site activities, Surrounding Sources, background concentrations.
2 – Additional exceedances above and over Bringelly AQMS

Figure 16 Daily Contemporaneous Analysis for Receptor R4

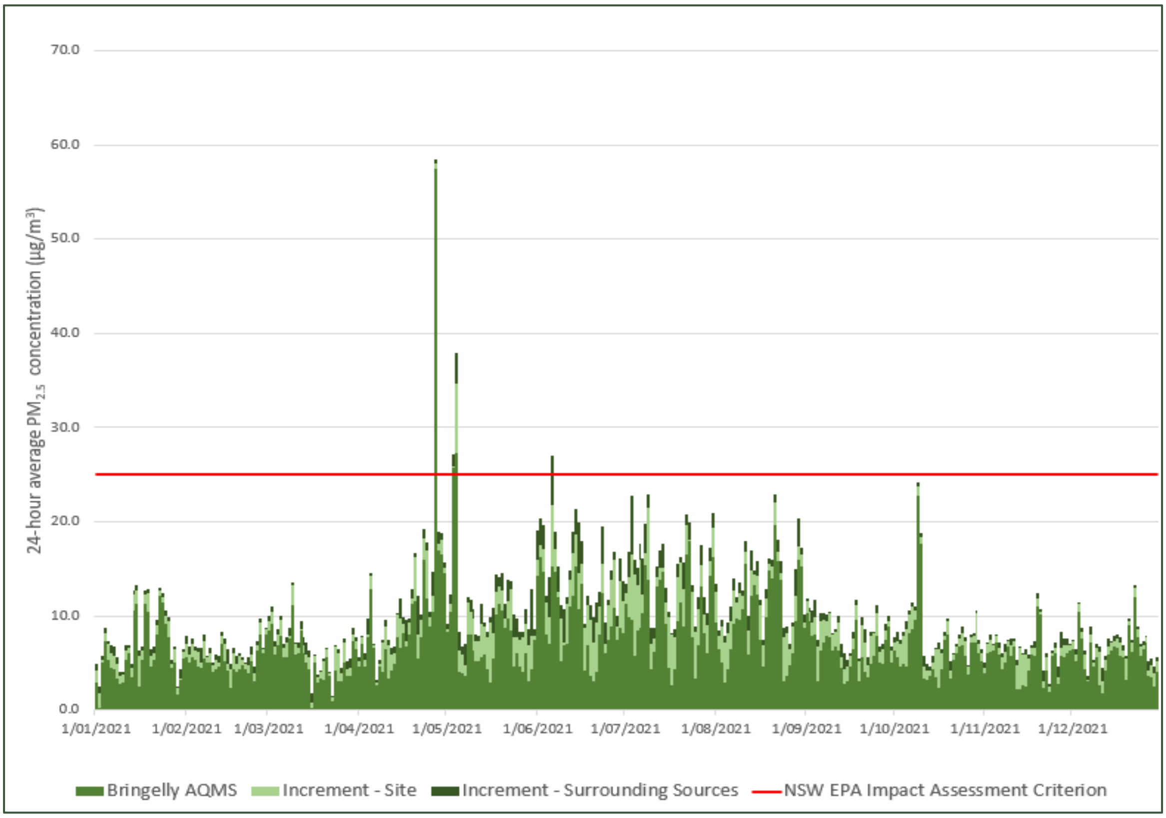
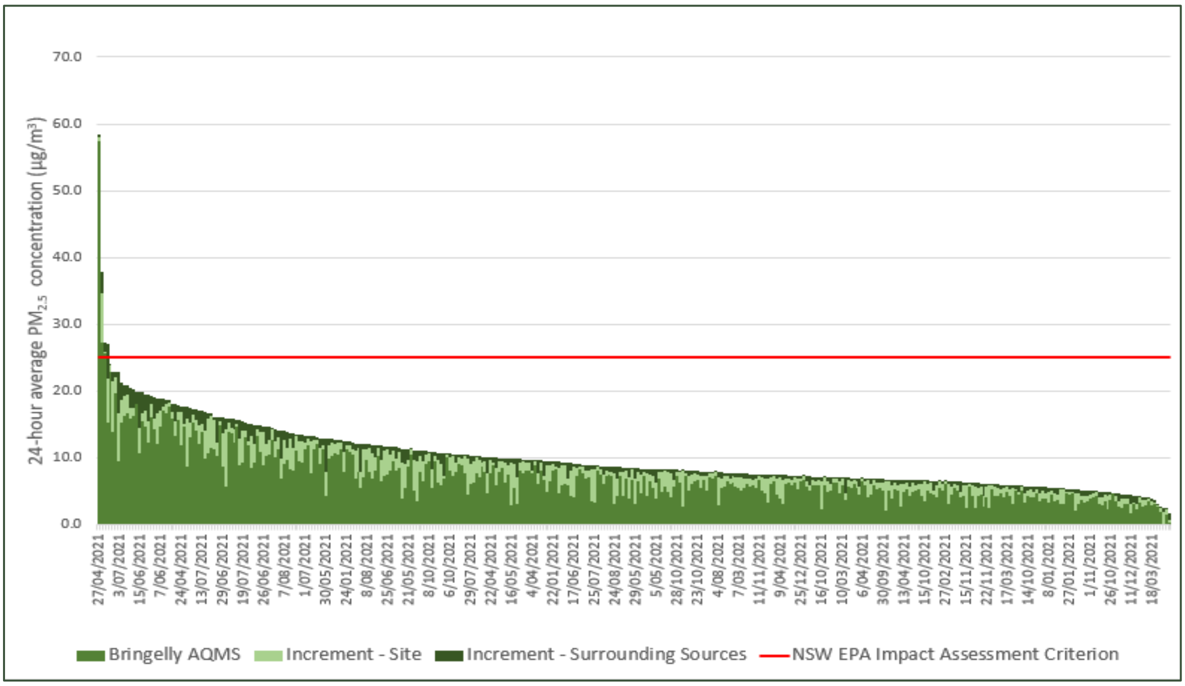


Figure 17 Ranked Daily Contemporaneous Analysis for Receptor R4



4.3.1.2 Annual Average $PM_{2.5}$ Concentrations

Table 13 summarises the incremental and cumulative annual average $PM_{2.5}$ impacts for the 10 most affected discrete receptor locations modelled. These locations were selected based on the annual average $PM_{2.5}$ increments predicted by the modelling due to the proposed bulk earthworks at the Site.

Cumulative impacts have been assessed against the $PM_{2.5}$ annual average criterion by combining predicted contributions from Site activities, Surrounding Sources, and background concentrations adopted from the Bringelly AQMS.

The cumulative annual average $PM_{2.5}$ concentrations are predicted to exceed the annual average $PM_{2.5}$ criterion of 8 µg/m³ at all 27 receptors modelled.

The highest cumulative impact is predicted at Receptor R4, followed by Receptors R15 and R23**.** All receptors presented in **Table 13** are predicted to experience exceedance above background concentrations due to the combined influence of Site activities and Surrounding Sources.

It is noted that the predicted annual average concentrations are likely to be conservative. Emission rates were derived using worst-case assumptions to ensure short-term impacts were not underestimated; however, these assumptions can result in an overestimation of longer-term annual average concentrations. In practice, cumulative annual impacts would be reduced where surrounding construction activities are not occurring concurrently, where effective dust mitigation controls are implemented across all sites, and where emissions are managed in accordance with the recommended Trigger Action Response Plan (TARP) and monitoring program outlined in **Section 4.4.1**.

Annual average $PM_{2.5}$ isopleths illustrating dispersion patterns across the modelling domain are provided in **Appendix C**.

Table 13 Top 10 Highest $PM_{2.5}$ Incremental Impact Receptors - Annual $PM_{2.5}$ Impact

Receptor ID	Annual Average $PM_{2.5}$ Concentrations (µg/m³)		Additional Exceedances[2] due to Site Activities & Surrounding Sources
	Incremental Impact	Cumulative Impact[1]	
R4	1.9	10.0	Yes
R15	1.7	9.8	Yes
R23	1.5	10.5	Yes
R6	1.4	9.7	Yes
R24	1.4	10.2	Yes
R2	1.4	9.6	Yes
R25	1.2	9.7	Yes
R12	1.2	9.4	Yes
R27	1.1	9.4	Yes
R11	0.8	9.0	Yes
Criterion		**8**	**-**

1 – Cumulative impact includes: Site activities, Surrounding Sources, and background concentrations.
2 – Additional exceedances above and over Bringelly AQMS

4.3.2 Particles as PM_{10}

4.3.2.1 Maximum 24-Hour Average PM_{10} Concentrations

Table 14 summarises the incremental and cumulative 24-hour average PM_{10} impacts for the 10 most affected discrete receptor locations modelled. These locations were selected based on the maximum 24-hour PM_{10} increments predicted by the modelling due to the proposed bulk earthworks.

A contemporaneous analysis was conducted to assess cumulative impacts against the relevant air quality criteria. This involved combining the incremental 24-hour $PM_{2.5}$ impacts from Site activities with the developments identified in **Section 4.2.2** (Surrounding Sources) and the daily varying background concentrations recorded at the Bringelly AQMS.

While cumulative 24-hour average PM_{10} concentrations are predicted to exceed the 50 µg/m³ criterion at all 27 modelled receptors, these results are influenced by elevated background levels. It is noted that the background data for the 2021 meteorological year already included one exceedance of the criterion, independent of the Site's activities.

Receptor R4, identified as having the highest incremental impact, is predicted to experience 31 additional exceedances above the background levels. However, further analysis indicates that the number of additional exceedances at R4 would decrease if emissions from surrounding construction sites are adequately controlled or if all Surrounding Sources are not simultaneously under construction. Further, the recommended trigger action response plan (TARP) and monitoring outlined in **Section 4.4.1** could significantly reduce the likelihood of additional exceedances.

A detailed daily analysis of Receptor R4 is presented in **Figure 18** to **Figure 19**, illustrating that incremental impacts from the Site are highest during the winter months. **Figure 19** illustrates that for the vast majority of days, throughout the year cumulative concentrations are well below the relevant criterion at the most impacted receptor.

Isopleths showing dispersion patterns across the modelling domain are provided in **Appendix D**.

Table 14 Top 10 Highest PM_{10} Incremental Impact Receptors - 24-Hour PM_{10} Impact

Receptor ID	Maximum 24-Hour Average PM_{10} Concentrations (µg/m³)		Additional Exceedances[2] due to Site Activities & Surrounding Sources	Additional Exceedances[2] due to Site Activities
	Incremental Impact	Cumulative Impact[1]		
R4	54.6	90.6	31	8
R6	54.4	83.3	34	9
R27	52.1	83.6	19	5
R23	50.9	87.3	32	7
R15	48.7	87.8	24	7
R24	48.7	86.2	25	6
R2	44.4	82.4	18	5
R25	44.2	84.8	17	3
R12	42.0	77.4	17	5
R11	31.4	74.9	14	0
Criterion		**50**	**-**	**-**

1 – Cumulative impact includes: Site activities, Surrounding Sources, background concentrations.
2 – Additional exceedances above and over Bringelly AQMS

Figure 18 Daily Contemporaneous Analysis for Receptor R4

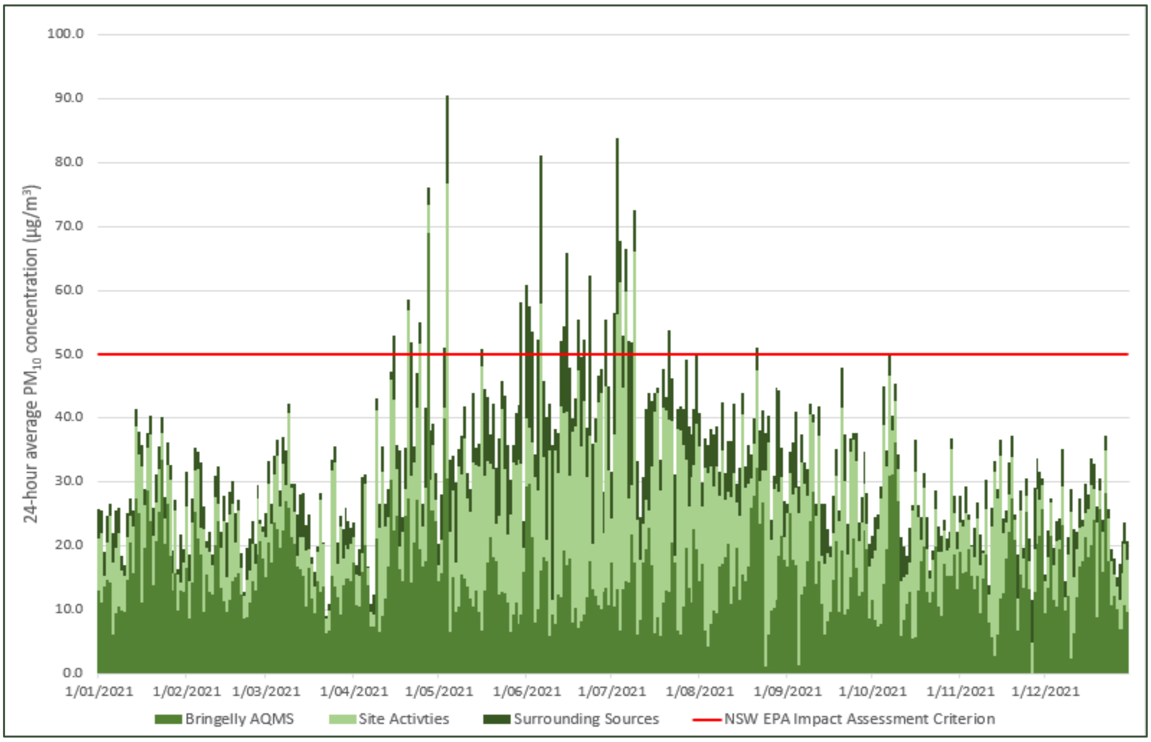
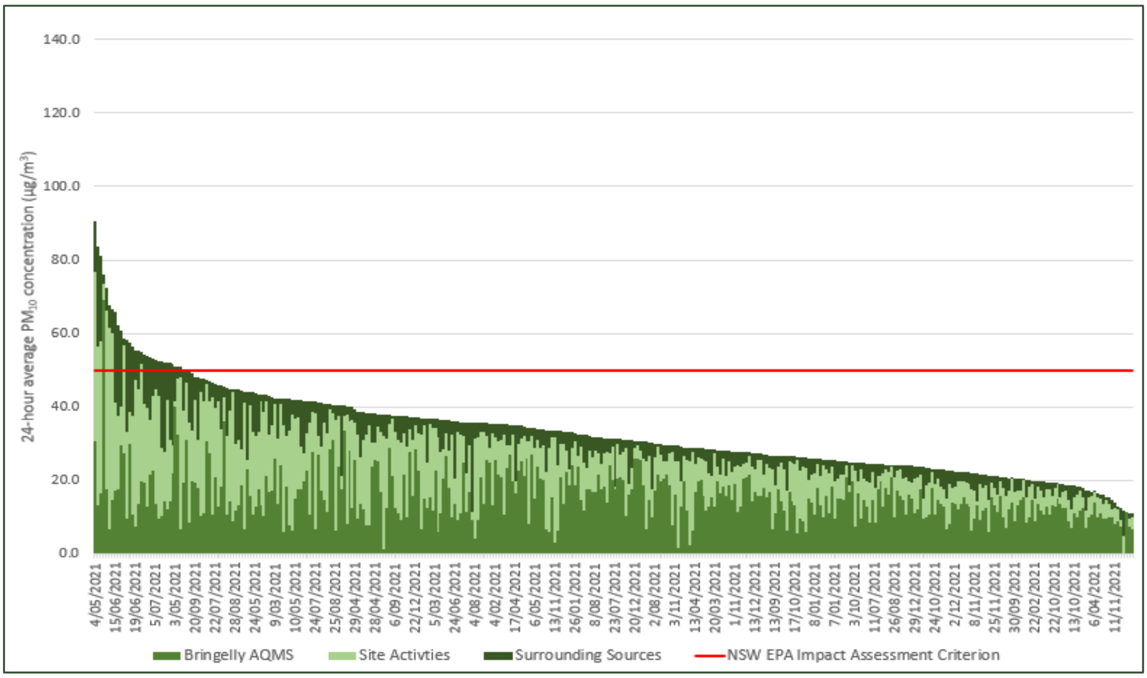


Figure 19 Ranked Daily Contemporaneous Analysis for Receptor R4



4.3.2.2 Meteorological Conditions Contributing to Exceedances

In order to determine the meteorological conditions associated with the highest PM_{10} contributions at the most affected locations, time series of predicted 1-hour average PM_{10}concentrations were extracted for a selection of identified worst-case receptors, including the worst impacted receptor (R4). These data were combined with the corresponding wind speed and wind direction to generate the polar plots presented in **Figure 20**.

The polar plots illustrate how predicted PM_{10} contributions at each receptor vary as a function of both wind speed and wind direction. All plots are presented on the same arbitrary colour scale to enable direct comparison between receptors.

Review of **Figure 20** indicates that, for all receptors shown (R4, R6, R15, R23, R24 and R27), the highest PM_{10} contributions are consistently associated with low wind speeds, generally below approximately 2 m/s. This pattern suggests that calm or near-calm conditions limit atmospheric dispersion, resulting in increased dust accumulation at these receptors. As wind speeds increase beyond this range, predicted contributions decrease markedly, indicating more effective dispersion under moderate to higher wind conditions.

The dominant wind direction associated with the highest PM_{10} contributions varies between receptors, reflecting their differing locations relative to the Site. Given that receptors are distributed in multiple directions around the Site, these results indicate that mitigation measures should be robust to low-wind conditions across all wind directions, rather than targeting a single prevailing sector.

Figure 21 presents the annual and seasonal wind roses for the Site based on the meteorological dataset used in the dispersion modelling for the proposed operating hours (7 am to 5 pm). Review of these wind roses indicates that low wind speed conditions occur least frequently during spring and are least common for winds originating from the northwest.

This suggests that the meteorological conditions most conducive to elevated PM_{10} concentrations at nearby receptors are relatively infrequent during typical operational periods but represent critical conditions for the assessment of worst-case impacts.

Figure 20 Polar Plots of Predicted 1-hour Average PM_{10} Contribution at Selected Worst Impacted Receptors

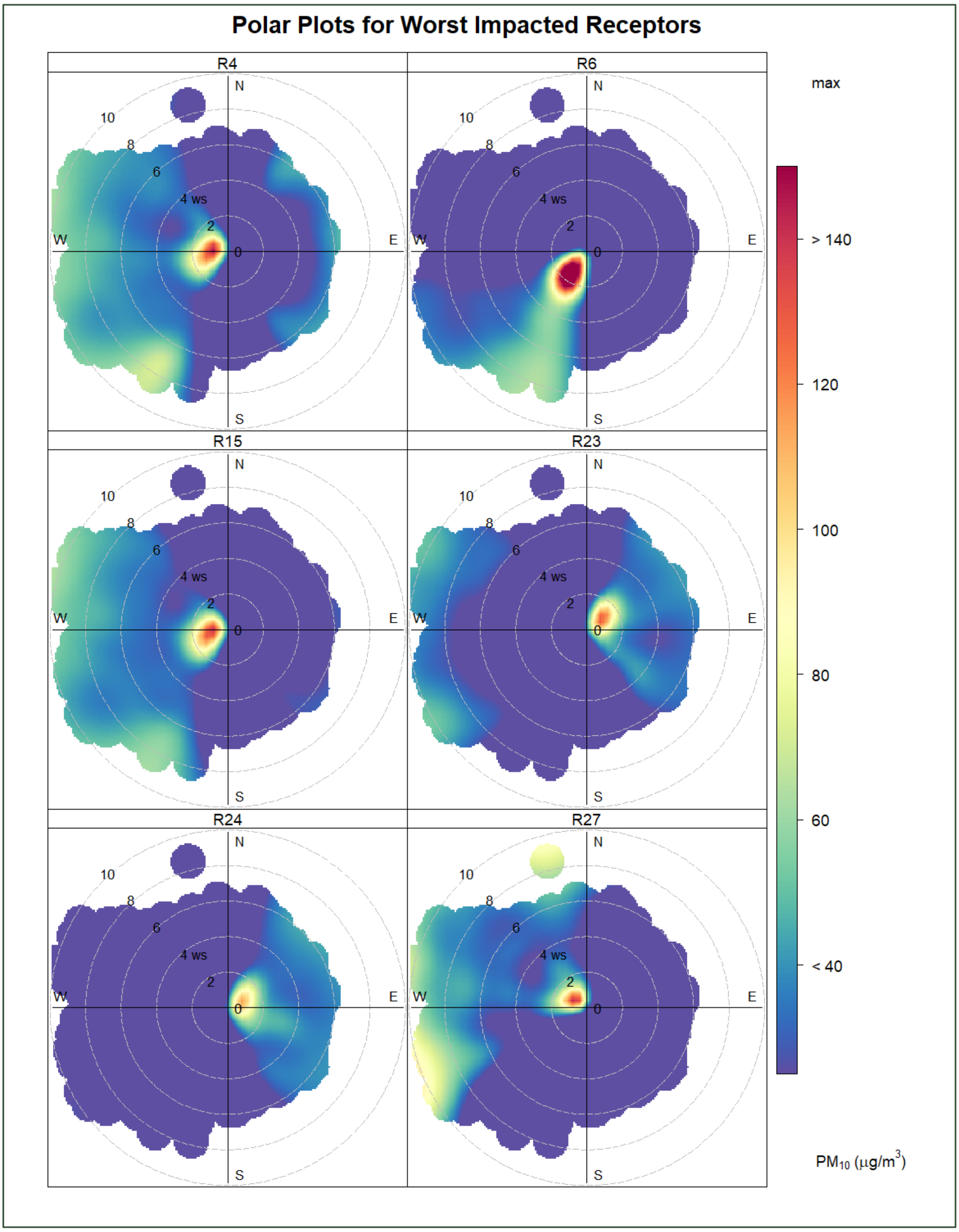
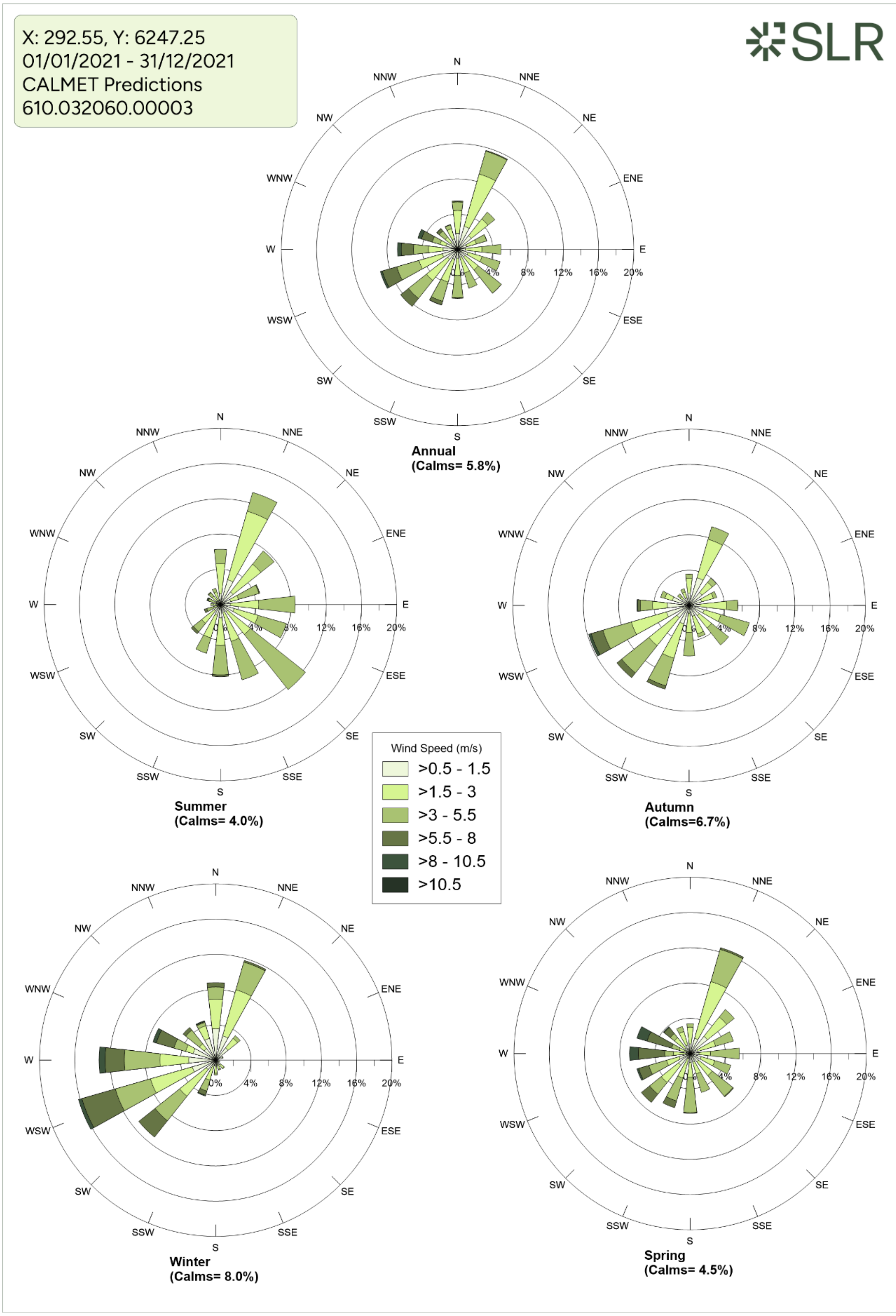


Figure 21 Annual and Seasonal Windroses at the Site: 7am – 5pm



4.3.2.3 Annual Average PM_{10} Concentrations

Table 13 summarises the incremental and cumulative annual average PM_{10} impacts for the 10 most affected discrete receptor locations modelled. These locations were selected based on the annual average PM_{10} increments predicted by the modelling due to the construction activities at the Site.

Cumulative impacts against the criterion have been considered by including the annual average concentrations from Site activities, Surrounding Sources, and background concentrations adopted from the Bringelly AQMS.

The cumulative annual average PM_{10} concentrations are predicted to exceed the annual average PM_{10} criterion of 25 µg/m^3 at 18 of the 27 receptors modelled. However, these predictions are expected to overestimate the impacts as the conservative assumptions used in the emission estimation to ensure short-term impacts were not underestimated lead to an overestimation of annual averages.

As outlined previously, cumulative impacts would decrease if emissions from surrounding construction sites are adequately controlled, if all Surrounding Sources are not simultaneously under construction or if the recommended TARP and monitoring outlined in **Section 4.4.1** is implemented**.** Isopleths showing dispersion patterns across the modelling domain are provided in **Appendix D**.

Table 15 Top 15 Highest PM_{10} Incremental Impact Receptors - Annual PM_{10} Impact

Receptor ID	Annual Average PM_{10} Concentrations (µg/m^3)		Additional Exceedances[2] due to Site Activities & Surrounding Sources
	Incremental Impact	Cumulative Impact[1]	
R4	12.3	33.1	Yes
R6	9.3	30.8	Yes
R27	7.3	28.4	Yes
R23	9.9	34.4	Yes
R15	10.8	31.7	Yes
R24	9.3	32.9	Yes
R2	9.2	30.2	Yes
R25	7.8	29.9	Yes
R12	7.7	28.8	Yes
R11	5.0	26.8	Yes
Criterion		**25**	

1 – Cumulative impact includes: Site activities, Surrounding Sources, background concentrations.
2 – Additional exceedances above and over Bringelly AQMS

4.3.3 Particles as TSP

4.3.3.1 Annual Average TSP Concentrations

Table 16 summarises the incremental and cumulative annual average TSP impacts for the 10 most affected discrete receptor locations modelled. These locations were selected based on the annual average TSP increments predicted by the modelling due to the proposed bulk earthworks at the Site.

Cumulative impacts against the criterion have been considered by including the annual average concentrations from Site activities, surrounding sources, and estimated background concentrations. Background TSP concentrations have been calculated from PM_{10} concentrations at Bringelly AQMS during 2021 assuming a PM_{10}/TSP ratio of 0.4

The cumulative annual average TSP concentrations are predicted to comply with the annual average TSP criterion of 90 µg/m^3 at all 27 receptors modelled. As outlined in previously, annual average predictions overestimate the impacts as the conservative assumptions used in the emission estimation to ensure short-term impacts were not underestimated lead to an overestimation of annual averages.

In addition, cumulative impacts would decrease if emissions from surrounding construction sites are adequately controlled, if all surrounding sources are not simultaneously under construction or if the recommended TARP and monitoring outlined in **Section 4.4.1** is implemented**.** Isopleths showing dispersion patterns across the modelling domain are provided in **Appendix D**.

Table 16 Predicted Incremental and Cumulative Annual Average TSP Concentrations

Receptor ID	Annual Average TSP Concentrations (µg/m^3)	
	Incremental Impact	Cumulative Impact[1]
R4	29	79
R15	26	76
R23	24	83
R6	24	75
R24	23	80
R2	22	72
R25	19	72
R12	19	69
R27	18	68
R11	12	64
Criterion	**-**	**90**

1 – Cumulative impact includes: Site activities, Surrounding Sources, and background concentrations.

4.3.4 Dust Deposition

Table 17 summarises the incremental and cumulative annual average dust deposition rates predicted at the 10 most affected discrete receptor locations modelled. These receptors were selected based on the highest annual average dust deposition increments predicted by the dispersion modelling for the proposed bulk earthworks at the Site.

Cumulative dust deposition impacts have been assessed by combining contributions from Site activities, surrounding construction sources, and an assumed background dust deposition rate of 2 g/m²/month, consistent with typical residential and mixed-use environments and the assumptions adopted for this assessment.

The predicted incremental annual average dust deposition rates are at or below the nominated criterion of 2 g/m²/month at all 27 modelled receptors. As shown in **Table 17** cumulative annual average dust deposition rates are below the adopted cumulative criterion of 4 g/m²/month at all receptors with the exception of R4 and R23 which marginally exceed the cumulative criteria.

As outlined previously, annual average dust deposition predictions are expected to be conservative. This is because the emission estimates and modelling assumptions were adopted to ensure that potential short-term impacts were not underestimated, which may result in an overestimation of longer-term average deposition rates.

In practice, cumulative dust deposition impacts would be further reduced where emissions from surrounding construction sites are effectively managed, where multiple sites are not under construction concurrently, and where the recommended mitigation measures, real-time monitoring, and Trigger Action Response Plan (TARP) outlined in **Section 4.4** are implemented.

Table 17 Predicted Annual Average Dust Deposition Rates

Receptor ID	Annual Average Dust Deposition Rate (g/m²/month)	
	Incremental Impact	Cumulative Impact[1]
R4	1.6	4.1
R15	1.5	3.9
R2	1.2	3.7
R23	1.1	4.2
R12	1.0	3.4
R24	1.0	3.9
R6	0.9	3.4
R27	0.9	3.4
R25	0.8	3.5
R11	0.6	3.1
Criterion	**2 g/m²/month**	**4 g/m²/month**

1 – Cumulative impact includes: Site activities, Surrounding Sources, and background concentrations.

4.4 Mitigation, Management & Monitoring Recommendations

The results of the dispersion modelling indicate that, under conservative worst-case assumptions, potential exceedances of short-term (24-hour) PM_{10} criteria and long-term (annual average) $PM_{2.5}$ criteria and dust deposition criteria may occur during the construction phase if appropriate mitigation measures are not implemented. These predicted impacts are primarily driven by intentionally conservative assumptions adopted to ensure short-term impacts are not underpredicted, including assumptions regarding concurrent construction activities, extended operating periods, and limited quantification of mitigation effectiveness.

As a consequence, the modelling is expected to overestimate long-term average impacts. Provided that effective measures are implemented to ensure compliance with the relevant short-term criteria, exceedances of the long-term particulate criteria are considered unlikely in practice.

The dust control and mitigation measures that have been explicitly quantified and incorporated into the detailed emission inventories used for the derivation of an emission factor for construction activities (see **Section 4.2**) are presented in **Table 18**. Additional recommended mitigation and management measures are provided in **Table 19** to **Table 22**. It is noted that the full benefits of all mitigation measures could not be quantified within the modelling, and therefore the predicted impacts remain conservative.

The recommended mitigation measures should be formalised within a site-specific Construction Air Quality Management Plan (CAQMP) to be prepared and implemented prior to the commencement of construction works. The CAQMP should address all relevant sources of air emissions identified in **Section 1.4.1**of this AQIA, includes wind erosion, wheel-generated dust, earthworks, material handling, and processing of excavated material.

In addition, it is recommended that the Site implement a Trigger Action Response Plan (TARP) supported by real-time PM_{10} monitoring to enable proactive management of construction-related air quality impacts. The TARP should be based on 1-hour average PM_{10} concentrations, supplemented by meteorological conditions and visual observations, and include staged response measures as outlined in **Section 4.4.1**.

Due to the inherently variable nature of construction activities, on-site operations and the extent of active disturbance may differ from the assumptions adopted in this assessment at any given time. While this AQIA does not predict every possible operational variation, adherence to the recommended mitigation measures, real-time monitoring, and the TARP framework will provide adequate flexibility to manage changing site conditions and ensure that any short-term changes in active disturbed areas do not result in unacceptable air quality impacts at sensitive receptors.

Table 18 Dust Mitigation Measures Adopted by the Assessment

Control Measure	Control Efficiency
Water carts used while scrapers stripping	50%
Water carts used while scraper travels	75%
Water carts used on haulage routes (Level 2 watering (>2 L/m^2/h)	75%
Water carts used with dozer activities*	50%
Water carts used with grader activities	50%
Water carts used on exposed area	50%
Source: (DSEWPC 2012) *Assumed to be similar to scrapers stripping.	

Table 19 Recommended Dust Mitigation Measures for the Site

	Activity
1	Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager.
2	Display the head or regional office contact information.
3	Develop and implement a CAQMP which includes a TARP, details of the proposed monitoring program as well as measures to control dust and if required other emissions (such as odour and combustion gases).
Site Management	
4	Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken.
5	Make the complaints log available to the local authority when asked.
6	Record any exceptional incidents that cause dust and/or air emissions, either on- or off-site, and the action taken to resolve the situation in the logbook.
Monitoring	
7	Undertake realtime monitoring and daily on-site and off-site inspections, where receptors are nearby, to monitor dust, record inspection results, and make the log available to the local authority when asked.
8	Carry out regular site inspections to monitor compliance with the DMP, record inspection results, and make an inspection log available to the local authority when asked.
9	Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.
Preparing and Maintaining the Site	
10	Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible.
11	Erect solid screens or barriers around dusty activities or the site boundary that are at least as high as any stockpiles on site.
12	Fully enclose site or specific operations where there is a high potential for dust production and the site is actives for an extensive period
13	Avoid site runoff of water or mud.
14	Keep site fencing, barriers and scaffolding clean using wet methods.
15	Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover as described below.
16	Cover, seed, or fence stockpiles to prevent wind whipping where possible and when stored for extended periods.
Operating Vehicle/Machinery and Sustainable Travel	
17	Ensure all vehicles switch off engines when stationary - no idling vehicles.

	Activity
18	Avoid the use of diesel- or petrol-powered generators and use mains electricity or battery powered equipment where practicable.
19	Impose and signpost a maximum-speed-limit of 20 km/h on surfaced and 10 km/h on un-surfaced haul roads and work areas (if long haul routes are required these speeds may be increased with suitable additional control measures provided, subject to the approval of the nominated undertaker.
Operations	
20	Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems.
21	Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate.
22	Use enclosed chutes and conveyors, and covered skips.
23	Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and using fine water sprays on such equipment wherever appropriate.
24	Ensure equipment is readily available on site to clean any dry spillages and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.
Waste Management	
25	Avoid bonfires and burning of waste materials.

Table 20 Mitigation Measures Specific to Earthworks

Activity
Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable.
Use Hessian, mulches or trackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.
Only remove the cover in small areas during work and not all at once.

Table 21 Mitigation Measures Specific to Construction

Activity
Avoid scabbling (roughening of concrete surfaces) if possible.
Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place.
Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.
For smaller supplies of fine power materials, ensure bags are sealed after use and stored appropriately to prevent dust.

Table 22 Mitigation Measures Specific to Trackout

Activity
Use water-assisted dust sweeper(s) on the access and local roads, to remove, as necessary, any material tracked out of the site. This may require the sweeper being continuously in use.
Avoid dry sweeping of large areas.
Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.
Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.
Record all inspections of haul routes and any subsequent action in a site log book.
Install hard-surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned.
Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site, where reasonably practicable).
Ensure there is an adequate area of hard-surfaced road between the wheel wash facility and the site exit, wherever site size and layout permit.
Access gates to be located at least 10 m from receptors where possible.

4.4.1 Recommended Ambient Air Quality Monitoring

Ambient air quality monitoring is proposed to assist in mitigating potential impacts at sensitive receptors. An example monitoring program is provided in **Table 23**.

As discussed in **Section 4.3.2.2**, as there are receptors in all directions from Site, there is not a predominate wind direction causing impacts at receptors, therefore it is recommended that monitors are located in each direction near the most impacted receptors as required.

It is recommended that monitoring locations are reviewed periodically to ensure representative of current construction activities and the seasonal variation in wind directions presented in **Figure 21**.

Table 23 Air Quality and Meteorological Monitoring Program

Actions	Frequency
Conduct real-time continuous PM_{10} monitoring and monthly DDG sampling at locations representative of nearest sensitive receptors & prevailing wind directions.	Continuously during construction.
Continuous meteorological data will be recorded from an on-site station including wind speed and wind direction as a minimum.	Continuously during construction.

4.4.2 Recommended Trigger Action Response Plan

Trigger action response plans (TARPs) define the minimum set of actions required by workers in response to a deviation from normal working conditions.

A 1-hour average time period has been selected as a practical time-step for identifying sustained elevated dust concentrations that could potentially result in an exceedance of the NSW EPA 24-hour average PM_{10} criterion, while providing sufficient time for additional mitigation measures to be implemented at the Site to reduce dust emissions before such an exceedance occurs.

Table 24 presents recommended 1-hour average PM_{10} concentrations and actions. In the absence of local guidance, these values are adapted from the recommendation in the UK Institute of Air Quality Management (IAQM) Guidance on Monitoring in the Vicinity of Demolition and Construction Sites (IAQM 2018) that was developed based on extensive monitoring in the vicinity of construction sites and recommended a 1-hour average PM_{10} concentration of 190 µg/m^3 as the trigger upon which action must immediately be taken to minimise dust emissions. The upper trigger has been conservatively lowered to 150 µg/ m^3.

Table 24 TARP PM_{10} Trigger Levels and Responses

Level	1-hour Average PM_{10} Trigger Level	Action
Alert	≥100 µg/m^3 but < 125 µg/m^3 Or Wind speed < 2m/s Or Visible dust leaving the Site	• Review operations via a visual inspection of dust emissions from current activities to ensure all standard dust mitigation measures are being appropriately implemented. Where appropriate, implement additional remedial measures, such as: ○ Deployment of additional water sprays, water trucks etc • Determine if background concentrations may be the key contributor to high concentrations being recorded (e.g., based on wind direction, information on regional events such as bush fires or dust storms, etc). • Continue to closely monitor PM_{10} concentrations being recorded.
Action I	≥125 µg/m^3 but < 150 µg/m^3 AND Wind speed < 2m/s Or Visible dust leaving the Site	• Increase watering rates on haul roads where appropriate. • Reduce the speed of equipment/vehicles. • Continue to closely monitor PM_{10} concentrations being recorded. • Investigate the dust generating activities, and if necessary, temporarily halt the dust-generating activities
Action II	≥ 150 µg/m^3 AND Wind speed < 2m/s AND Or Visible dust leaving the Site	• Review planned operations considering exposed areas. • Cease any non-critical dust-producing activities or relocate relevant activities where possible away from sensitive receptors, or to less exposed locations. • Continue to closely monitor PM_{10} concentrations being recorded.

5.0 Operational Air Quality Assessment

5.1 Pollutants Assessed

RAQST provides predictions of NO_2, PM_{10} and $PM_{2.5}$ concentrations at various distances from the road kerb. It does not provide predictions of the other traffic-related pollutants identified in **Section 1.4.2**, namely CO, SO_2 and VOCs. Given the low level of CO and SO_2 emissions from vehicles and the low ambient concentrations recorded in the region (see **Section 3.5**), it is reasonable to assume that CO and SO_2 emissions from road traffic are unlikely to result in any exceedances of the relevant criteria at locations beyond the road kerb. SLR's experience in modelling VOC emissions from roads has also shown that the kerbside concentration of VOCs is typically well below the relevant air quality guidelines.

Given the above, CO, SO_2 and VOC traffic emissions have not been considered further in this assessment.

5.2 Modelling Assumptions

Table 25 presents the anticipated hourly traffic generation associated with the operation of the Site, based on traffic advice provided by ASON. The total forecast Average Annual Daily Traffic (AADT) generated by the development is 2,171 vehicles per day (vpd).

The traffic composition during the peak hour is assumed to include an average of 27% heavy vehicles, based on the proportional split provided by the client and reflected in **Table 25**.

For this assessment, it has been conservatively assumed that all Site-generated vehicles enter and exit the Site via the same access point on the Lawson Road extension and travel in a single direction past the nearest affected sensitive receptor. This represents a worst-case scenario in terms of potential air quality impacts, as in practice, traffic movements will be distributed across multiple directions and time periods.

The closest existing sensitive receptor to Lawson Road is located approximately 25 m from the Lawson Road Kerbside.

Table 25 Peak Hour Traffic Generation

Start Time	All Vehicle	Light Vehicle	Heavy Vehicle
0:00	18	13	5
1:00	16	10	5
2:00	17	12	6
3:00	19	15	5
4:00	61	51	10
5:00	117	94	23
6:00	158	126	33
7:00	157	118	39
8:00	145	100	45
9:00	126	77	49
10:00	118	71	48
11:00	124	75	48
12:00	135	91	44

Start Time	All Vehicle	Light Vehicle	Heavy Vehicle
13:00	162	118	44
14:00	177	137	40
15:00	151	116	35
16:00	126	98	28
17:00	104	80	24
18:00	62	45	16
19:00	37	27	10
20:00	27	19	8
21:00	35	29	6
22:00	45	38	7
23:00	32	26	6
Total	**2,171**	**1,587**	**584**
Note: Minor discrepancies between sum numbers due to 'rounding'.			

5.3 Dispersion Model Configuration

RAQST requires a number of inputs to describe the Site environment and emissions to air, including:

- Background pollutant concentrations
- Daily or peak hour traffic volumes and vehicle speeds
- Traffic mix (heavy vehicle percentage)
- Road type, number of lanes and gradient
- Year of assessment (vehicle fleet).

The sources of the required data and assumptions made for this assessment are summarised in **Table 26**.

Table 26 RAQST Input Data

Parameter	Value	Description
Assessment Year	2027	Assumed project completion
Electric vehicle projections	Included	-
Number of Lanes	1 in each direction	-
Road type	Arterial	Based on road type and land use of the area
Road gradient	+/- 1%	Average road gradients calculated based on terrain elevations.
Lane width (m)	3.5 m	Assumed
Level for traffic composition	Level 2 27% Heavy Vehicle 73% Light Vehicle split	No detailed information on traffic composition is available.
Traffic speed	10 km/hr	Conservative assumption representative of emissions during high congestion periods
Traffic volume	2,171 vpd (1,086 vpd per lane)	Peak incremental change
Peak hour traffic as a percentage of AADT	10%	Minimum Peak hour % in RAQST. This is a conservative setting asthe calculated peak hour traffic as a percentage of AADT is 8%
Heavy vehicle percentage	27%	Averaged from daily increment data provided by ASON.
Background Concentrations		
Background site	Bringelly AQMS	Nearest air quality monitoring station
Background year	2021	-
1-hour metric for NO_x	Maximum	Per the Approved Methods, if the existing ambient air pollutant concentrations exceed the impact assessment criteria, the assessment demonstrates that no additional exceedances of the impact assessment criteria will occur.
24-hour metric for PM_{10} and $PM_{2.5}$	Maximum below the criterion	

5.4 Modelling Results

The nearest receptors to the Lawson Road kerbside, which is the main access point for the Project, are located approximately 25 m from the kerb. Therefore, predicted air pollutant concentrations at 25 m from the kerbside have been quantified.

As shown in **Table 27**, the incremental concentrations associated with vehicle movements along Lawson Road are very small, representing approximately 5% of the annual NO_2 criterion, less than 1% of the PM_{10} criteria, and around 1% of the $PM_{2.5}$ criteria. These results indicate that project-related contributions are minimal and would not materially influence ambient air quality or contribute to exceedances of the relevant criteria.

Furthermore, all predicted cumulative concentrations comply with the applicable criteria. Accordingly, the overall air quality impact of the development is considered negligible. It is also noted that impacts at residential receptors located further from the kerbside would be lower than those presented in **Table 27** for the nearest receptors.

Table 27 RAQST Model Results

Pollutant and Averaging Period	Background Concentration (µg/m³)	Incremental Impact (µg/m³)	Cumulative Impact (µg/m³)	Criteria
Maximum 1-hour NO_2 concentrations	Not Applicable	Not applicable	132.8	**164**
Annual NO_2 concentrations	8.7	1.6	10.3	**31**
Maximum 24-hour PM_{10} concentrations	39.9	0.4	40.3	**50**
Annual PM_{10} concentrations	15.3	0.2	15.5	**25**
Maximum 24-hour $PM_{2.5}$ concentrations	22.8	0.3	23.1	**25**
Annual $PM_{2.5}$ concentrations	7.2	0.1	7.3	**8**

5.5 Mitigation Measures & Recommendations

In addition to dust and air emission mitigation measures for the construction phase provided in **Section 4.4**, recommended air quality management measures for the operational phase of the proposed activities under SSD-74191717 include:

- Minimising vehicle idling times around the Site using best management practices, including:
  - Requiring vehicle engines to be turned off when loading/unloading; when drivers are on a break, or waiting to get administrative clearances, etc.; and
  - Installation of appropriate signage at relevant locations encouraging drivers to switch off engines when not in use.
- Mobile heavy lift equipment and other vehicles operated on site are maintained and operated as per manufacturer specifications or best practice requirements.
- Any spillages are cleaned up in a timely manner.
- Sealed access roads and hardstand areas are maintained and the surface kept free of significant dust-generating materials.

6.0 Conclusions

This Air Quality Impact Assessment (AQIA) has evaluated the potential air quality impacts associated with the construction and operation of the proposed Badgerys Creek Industry Park, in accordance with the NSW EPA Approved Methods and relevant regulatory criteria.

The assessment identified that the primary air quality risk during construction relates to fugitive dust emissions (PM_{10}, $PM_{2.5}$ and TSP), particularly during bulk earthworks. A detailed Level 2 dispersion modelling assessment was undertaken using conservative assumptions, including extended construction hours, continuous activity, and simultaneous development of surrounding sites. The modelling results indicate that:

- Cumulative impacts, which include contributions from surrounding construction activities and background concentrations, are predicted to exceed the 24-hour $PM_{2.5}$ and PM_{10} criteria and annual average dust deposition criteria at several receptors.
- These exceedances are primarily driven by elevated background concentrations and concurrent regional construction activities, rather than the Site in isolation.
- Under certain meteorological conditions, high incremental concentrations of PM_{10}, $PM_{2.5}$ are predicted. However, these conditions are generally infrequent.

Construction-related air quality impacts would be temporary and variable, influenced by meteorological conditions (particularly wind speed and direction), as well as the intensity, scale and staging of construction activities.

The modelling adopts conservative assumptions, including peak construction scenarios and the simultaneous operation of surrounding sources. It also does not fully account for the effectiveness of proposed mitigation measures such as reduced vehicle speeds, adaptive management during adverse weather conditions, and rainfall effects. Accordingly, predicted impacts represent an upper-bound scenario.

With the implementation of recommended dust mitigation measures, including standard site management controls and the Trigger Action Response Plan (TARP) outlined in **Section 4.4.1**, emissions can be effectively managed and minimised, reducing potential impacts at surrounding sensitive receptors.

For the operational phase, emissions associated with vehicle movements were assessed using the RAQST screening tool. The results indicate that operational air quality impacts are negligible and well below relevant assessment criteria and therefore are not expected to constrain the development. Overall, the assessment concludes that:

- The Project is unlikely to result in significant adverse air quality impacts during the construction stage with appropriate mitigation, monitoring and management measures in place.
- Operational air quality impacts are minimal and not expected to constrain the ongoing use of the Site.

7.0 References

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Appendix A Selection of Representative Meteorological Data

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Meteorological Year Selection

Once emitted to atmosphere, the emissions will:

- Rise according to the momentum and buoyancy of the emission at the discharge point relative to the prevailing atmospheric conditions.
- Be advected from the source according to the strength and direction of the wind at the height which the plume has risen in the atmosphere.
- Be diluted due to mixing with the ambient air, according to the intensity of turbulence.
- (Potentially) be chemically transformed and/or depleted by deposition processes.

Dispersion is the combined effect of these processes. Dispersion modelling is used as a tool to simulate the air quality effects of specific emission sources, given the meteorology typical for a local area together with the expected emissions. Selection of a year when the meteorological data is atypical means that the resultant predictions may not appropriately represent the most likely air quality impacts. Therefore, in dispersion modelling, one of the key considerations is the representative nature of the meteorological data used.

The year of meteorological data used for the dispersion modelling was selected by reviewing the most recent five years of historical surface observations at (2020 to 2024 inclusive) to determine the year that is most representative of average conditions. Wind direction and wind speed were compared to averages for the region to determine the most representative year.

Data collected from 2020 to 2024 is summarised in **Figures A-1** to **A-2**. Examination of the data indicates the following:

Figure A-1 indicates relatively similar wind roses for all years analysed, with a higher frequency of winds from the west-southwest in 2024 .

Figure A-2 indicates that 2020 and 2021 exhibit wind speeds that are lower than the 5-year average which will result in a conservative assessment due to reduced dispersion.

Figure A-3 indicates that 2020, 2021 and 2022 are most similar to the 5-year average of calms conditions, however 2020 has a much higher frequency of calms than the 5-year average, which may be overly conservative if selected.

Figure A-3 i indicates relatively similar monthly temperatures for all years analysed, with some above average temperatures in 2024, 2023 and 2024.

Given the above, the year 2021 was selected as the representative year of meteorology.

Figure A-1 Frequency of Winds at Badgerys Creek AWS for 2020 – 2024

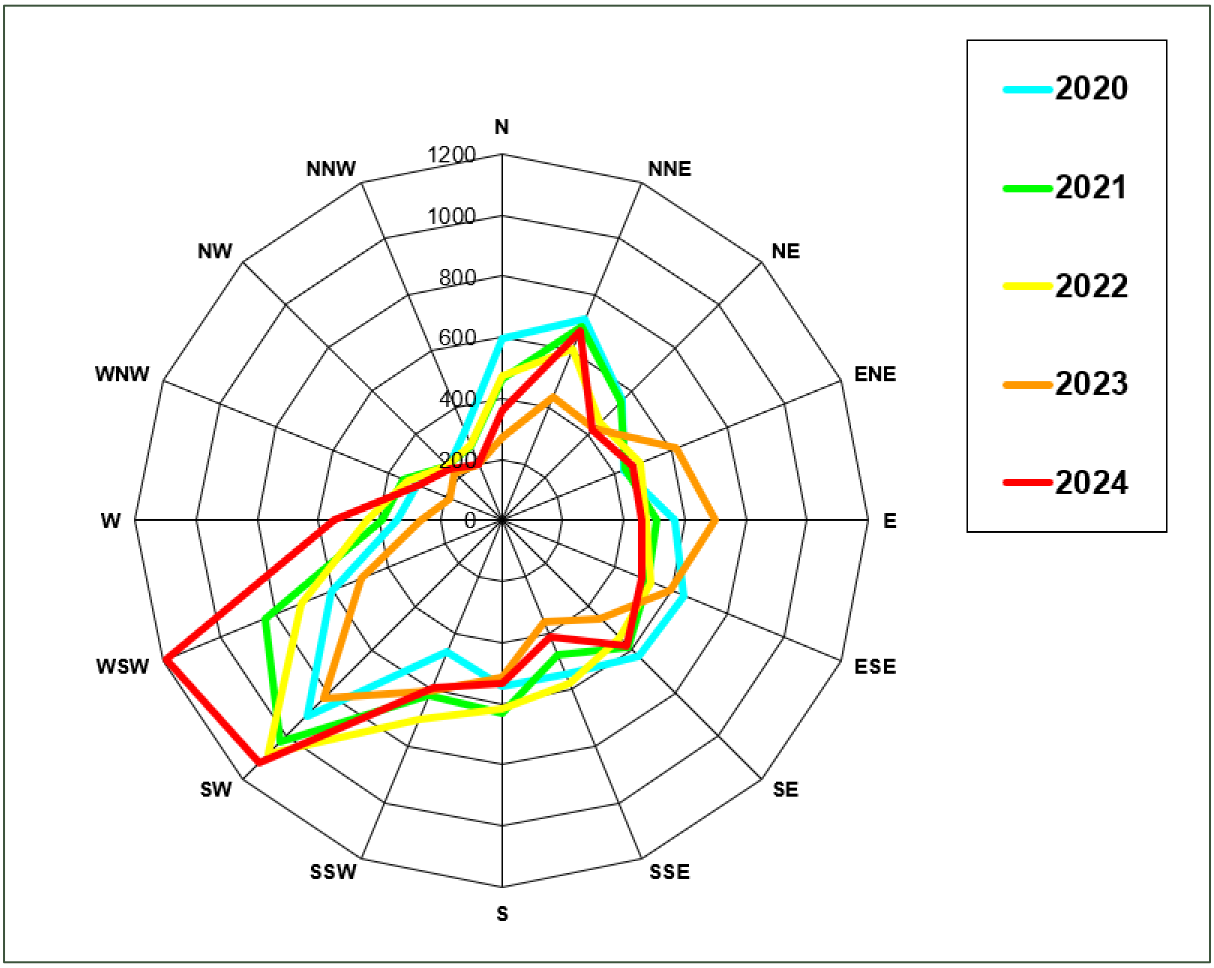


Figure A-2 Monthly Average Wind Speed at Badgerys Creek AWS for 2020 – 2024

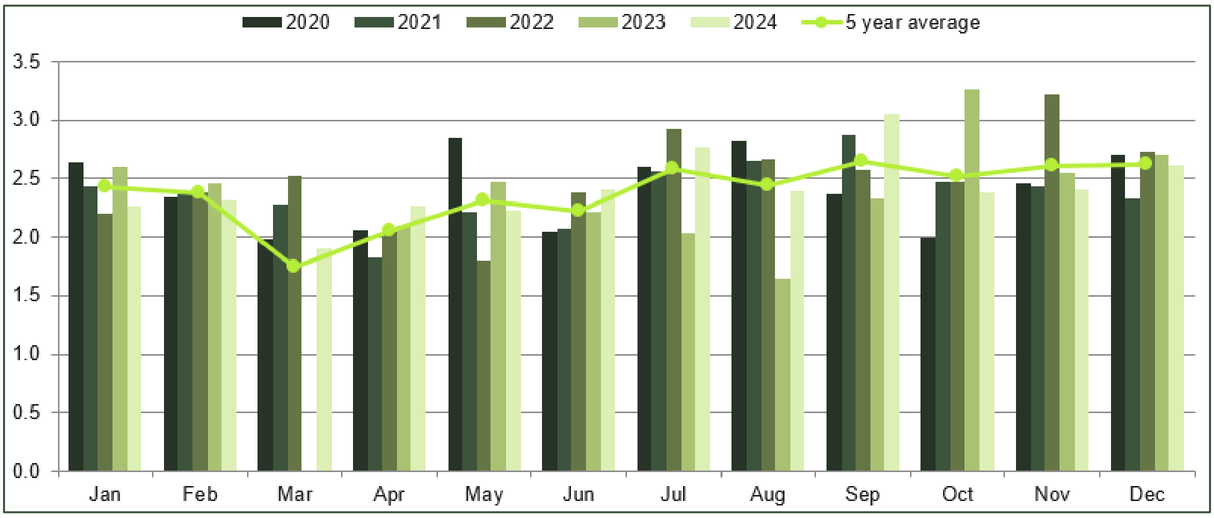


Figure A-3 Monthly Average Occurrence of Calms at Badgerys Creek AWS for 2020 – 2024

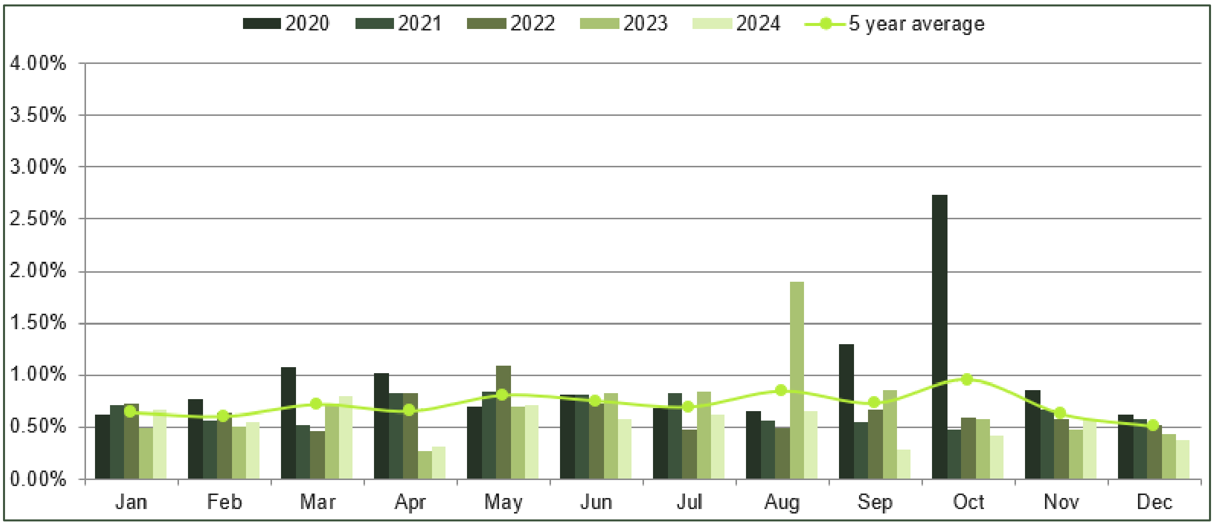
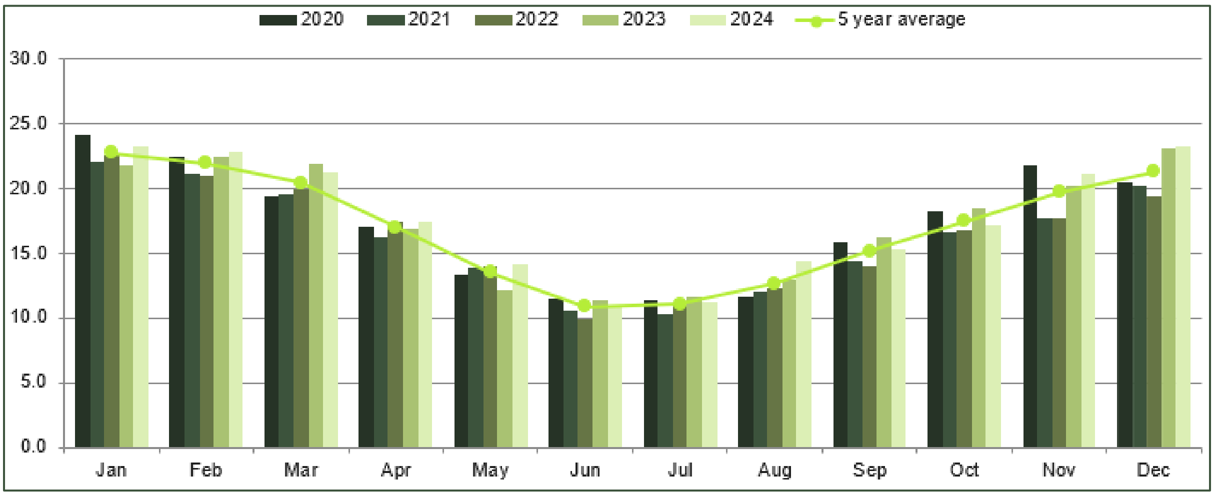


Figure A-4 Monthly Average Temperature at Badgerys Creek AWS for 2020 – 2024



Appendix B Evaluation of Meteorological Data

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The primary meteorological data parameters relevant for dispersion modelling are typically:

- wind (wind speed and direction)
- turbulence (atmospheric stability)
- mixing height (depth of turbulent layer)

A review of the meteorological data used in the dispersion modelling for the above parameters is provided below.

Wind Speed and Wind Direction

A summary of the annual wind behaviour predicted by CALMET for 2021 (extracted at the Site) is presented as wind roses in **Figure B-1** and as a wind speed distribution plot in **Figure B-2**. These plots show that winds in the study area were predicted to be predominantly light to moderate during 2021. Calm wind conditions were predicted to occur approximately 6.8% of the time throughout the modelling period. Generally, higher wind speeds and a low percentage of calm wind conditions will assist pollutant dispersion, resulting in lower pollution concentrations at the surrounding receptors.

The seasonal wind roses indicate that typically:

- In summer, winds blow from all directions except the northwestern quadrant, where winds occur infrequently. Calms were recorded approximately 5.8% of the time during the summer months.
- In autumn, winds predominantly blow from the southwestern quadrant, with the least frequent winds originating from the northeastern quadrant. Calms were recorded approximately 6.8% of the time during the autumn months.
- In winter, winds predominantly blow from the southwestern and northwestern quadrants, with the least frequent winds originating from the northeastern and southeastern quadrants. Calms were recorded 9.5% of the time.
- In spring, winds blow almost evenly from all directions, with fewer winds from the northwestern quadrant. Calms were recorded approximately 5.5% of the time.

A comparison of the wind roses presented in **Figure B-1** with the Badgerys Creek AWS wind roses presented in **Figure 9** shows that the frequency distribution of wind speed and direction for both is very similar throughout the year, with the CALMET predictions having slightly lower calm frequency. Based on the wind roses, the receptors with the greatest potential for air quality impacts are located to the northeast, as southwest winds are predominant, primarily in Winter and Autumn.

Figure B-1 CALMET-Predicted Seasonal Wind Roses for the Site – 2021

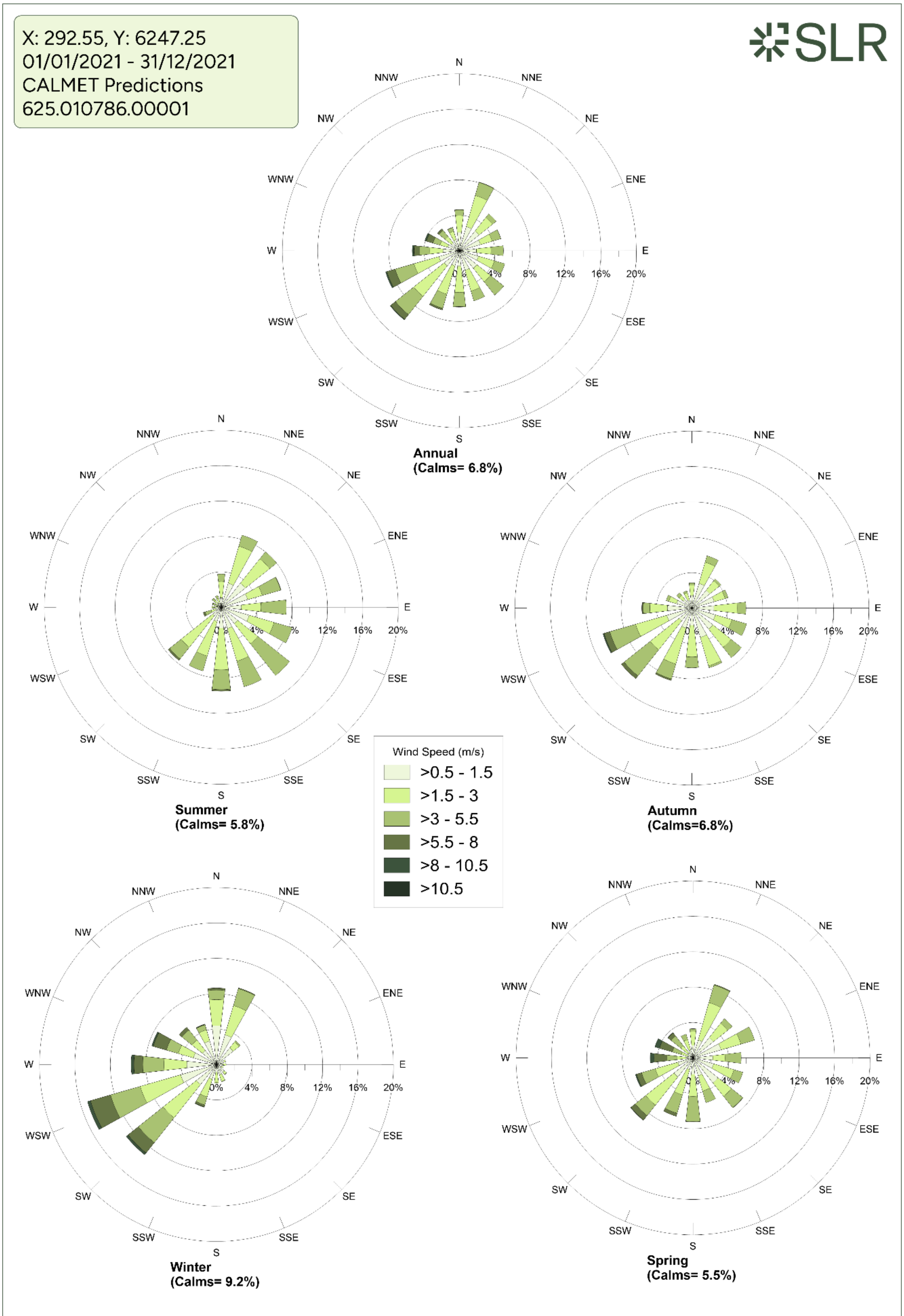
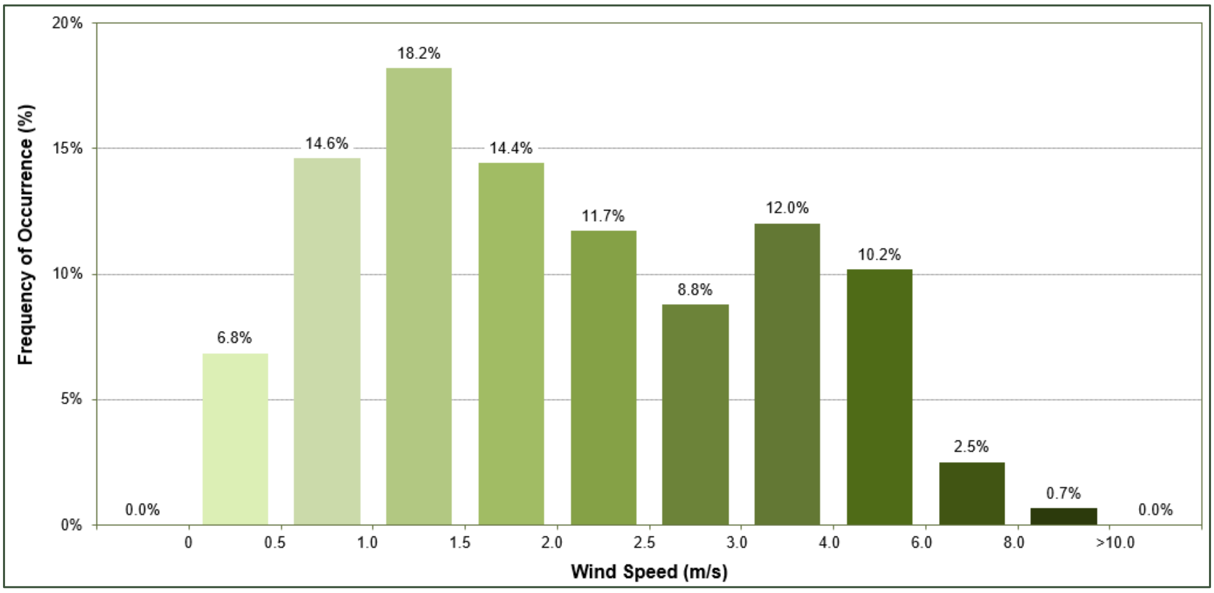


Figure B-2 Annual Wind Speed Frequencies at the Site (CALMET Predictions, 2021)



Atmospheric Stability

Atmospheric stability refers to atmospheric turbulence and the tendency of the atmosphere to resist or enhance vertical motion. Depending on conditions the atmospheric stability can either inhibit or promote pollutant dispersion. The Pasquill-Gifford scheme provides six stability classes, A to F, to categorise the degree of atmospheric stability as follows:

- A = Extremely unstable conditions
- B = Moderately unstable conditions
- C = Slightly unstable conditions
- D = Neutral conditions
- E = Slightly stable conditions
- F = Moderately stable conditions

The meteorological conditions defining each PGT stability class are shown in **Table B-1**.

Unstable conditions are favourable for dispersion, while stable conditions are unfavourable for dispersion.

The dispersion modelling in CALPUFF used a more advanced atmospheric stability scheme (based on micro meteorology). Stability class data was extracted from the meteorological dispersion modelling data set for the meteorological data evaluation.

Table B-1 Meteorological Conditions Defining PGT Stability Classes

Surface Wind Speed (m/s)	Daytime Insolation			Night-Time Conditions	
	Strong	Moderate	Slight	Thin overcast or > 4/8 low cloud	<= 4/8 cloudiness
< 2	A	A - B	B	E	F
2 - 3	A - B	B	C	E	F
3 - 5	B	B - C	C	D	E
5 - 6	C	C - D	D	D	D
> 6	C	D	D	D	D

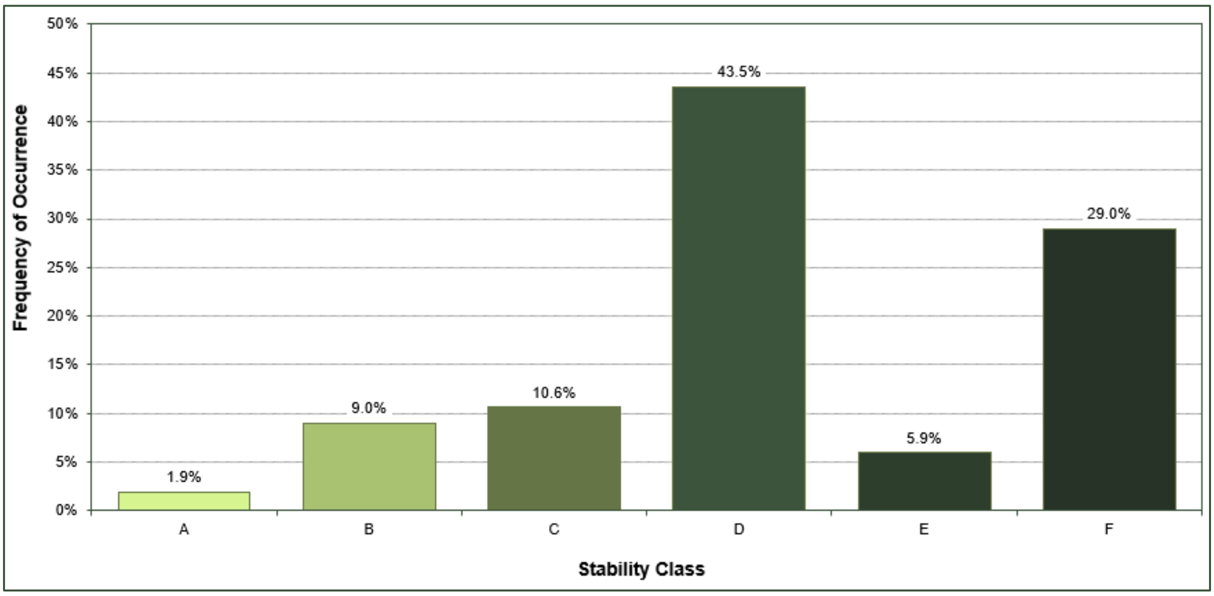
Source: (NOAA 2018)

Notes:

1. Strong insolation corresponds to sunny midday in midsummer in England, slight insolation to similar conditions in midwinter.
2. Night refers to the period from 1 hour before sunset to 1 hour after sunrise.
3. The neutral category D should also be used, regardless of wind speed, for overcast conditions during day or night and for any sky conditions during the hour preceding or following night as defined above.

The frequency of each stability class predicted by CALMET at the Site during the modelling period is presented in **Figure B-3**. The results indicate a high frequency of conditions typical to Stability Class D and F. Stability Class D is indicative of neutral conditions, conducive to a moderate level of pollutant dispersion due to mechanical mixing. Stability Class F is indicative of calm conditions, which typically indicates poorer dispersion of pollutants.

Figure B-3 Predicted Stability Class Frequencies at the Site (CALMET predictions, 2021)



Mixing Heights

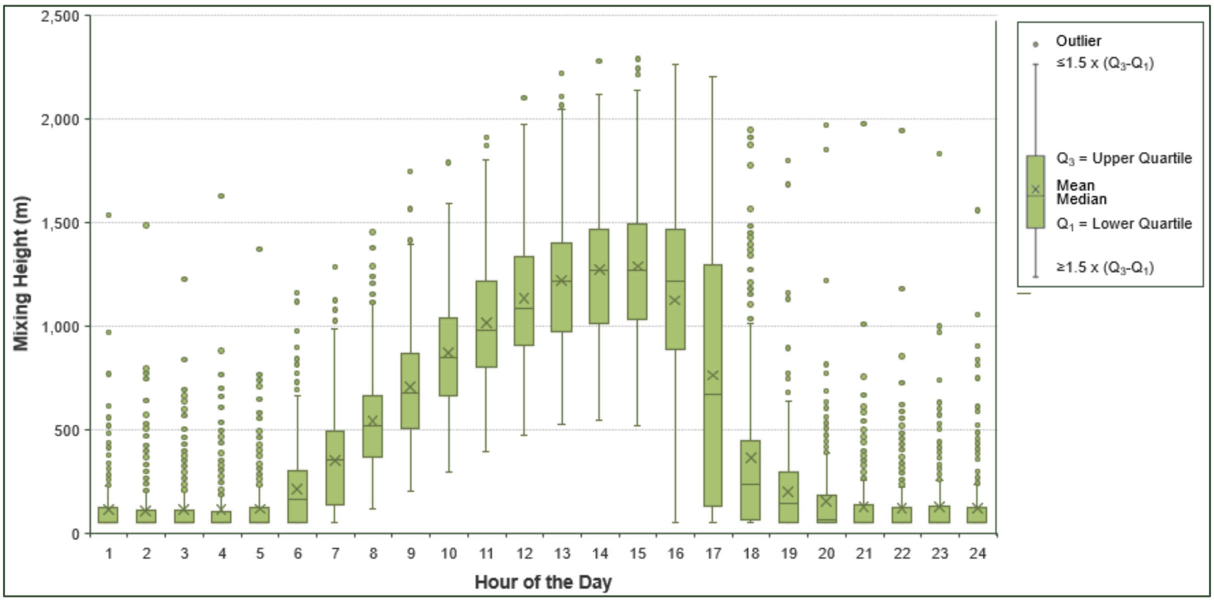
The mixing height is the depth of the atmospheric mixing layer between ground level and an elevated temperature inversion. Depending on conditions, vertical dispersion is typically limited by the mixing height. This is an important parameter in dispersion modelling since the mixing height largely sets the vertical profile the dispersion can take place in.

Mixing heights have a diurnal variation in response to mixing from convection due to insolation and grow from sunrise to around midday. Followed by a decline until sunset when there typically is a rapid decline. If a plume penetrates through, or is released above, the mixing height the pollutants will be trapped aloft with no mixing to ground level (unless in specific conditions such as fumigation). Similarly, if a plume is trapped below a low mixing height (inversion layer) the vertical dispersion will be limited, and higher ground-level concentrations are likely to occur.

Diurnal variations in maximum and average mixing heights predicted by CALMET at the Site during the 2021 modelling period are illustrated in **Figure B-4**.

As would be expected, an increase in mixing depth during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and growth of the convective mixing layer.

Figure B-4 Predicted Mixing Heights at the Site (CALMET predictions, 2021)



Appendix C Variable Emission File

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Variable Emission File – Calculation Steps

A brief summary of the steps used in calculating the hourly varying emission rates for each source are presented below.

Step 1: Calculate annual average emission rate (kg/year) for FP, CM and RE

FPannual = $PM_{2.5}$, annual	(FP) Fine Particulate – particulate of size less than 2.5 µm
CMannual = PM_{10}, annual – $PM_{2.5}$, annual	(CM) Coarse Particulate – particulate of size between 10 µm and 2.5 µm
REannual = TSPannual - PM10, annual	(RE) Rest Particulate – particulate of size greater than 10 µm

Step 2: Identify the operating hours for each activity

Step 3: Classify the sensitivity of each type of activity to wind speed

Wind insensitive: activities with emission factor that is independent of wind speed (e.g. blasting)

Wind sensitive: activities with emission factor that is a function of (wind speed/2.2)1.3 (e.g. loading)

Wind erosion: emission from exposed areas/stockpiles

Step 4: Identify the number of sources associated with each activity

Note that each wind erosion source is modelled as an independent source.

Step 5: Calculate the hourly average emission rate for each activity per source

$$FP_{AC,i,h} = \frac{FP_{annual,i} \times 1000}{N_{days} \times OH_i \times 3600 \times N_{s,i}} \times WSFactor_{i,h}$$ $$CM_{AC,i,h} = \frac{CM_{annual,i} \times 1000}{N_{days} \times OH_i \times 3600 \times N_{s,i}} \times WSFactor_{i,h}$$ $$RE_{AC,i,h} = \frac{RE_{annual,i} \times 1000}{N_{days} \times OH_i \times 3600 \times N_{s,i}} \times WSFactor_{i,h}$$ **FOR WIND INSENSITIVE ACTIVITIES** $$WSFactor_{i,h} = 1$$ **FOR WIND SENSITIVE ACTIVITIES** $$WSFactor_{i,h} = \frac{\left(\frac{WS_h}{2.2}\right)^{1.3}}{\frac{\sum_{j=1}^{n}\left(\frac{WS_j}{2.2}\right)^{1.3}}{n}}$$ **FOR WIND EROSION ACTIVITIES** $$WSFactor_{i,h} = \frac{(WS_h)^3}{\frac{\sum_{j=1}^{n}(WS_j)^3}{n}}$$	WHERE: FPAC,I,H- FINE PARTICULATES EMISSION RATE FOR ACTIVITY I (G/S) AT HOUR H CMAC,I,H- FINE PARTICULATES EMISSION RATE FOR ACTIVITY I (G/S) AT HOUR H CMAC,I,H- FINE PARTICULATES EMISSION RATE FOR ACTIVITY I (G/S) AT HOUR H OHI-DAILY OPERATING HOURS (1- 24) FOR ACTIVITY I NDAYS -NUMBER OF DAYS IN THE METEOROLOGICAL DATA FILE NS,I -NUMBER OF SOURCES ASSOCIATED WITH ACTIVITY I WSH-WIND SPEED AT THE HOUR N -NUMBER OF HOURS IN THE METEOROLOGICAL DATA FILE

Note: If the activity was modelled as area source, the equation on the left column of the table needs to be divided by the area of that activity.

Step 6: Calculate the hourly average emission rate for each source

To calculate the emission rate for a particular source for a particular hour, add up the calculated emission rate for each activity associated with source.

For example, if Source 1 is associated with Activity 1, Activity 2 and Activity 3, then:

ERS1,h,FP = FPAC,1,h+ FPAC,2,h+ FPAC,3,h

ERS1,h,CM = CMAC,1,h+ CMAC,2,h+ CMAC,3,h

ERS1,h,RE = REAC,1,h+ REAC,2,h+ REAC,3,h

Appendix D Isopleths

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Figure E-1 24-hour Average Incremental Impacts of $PM_{2.5}$

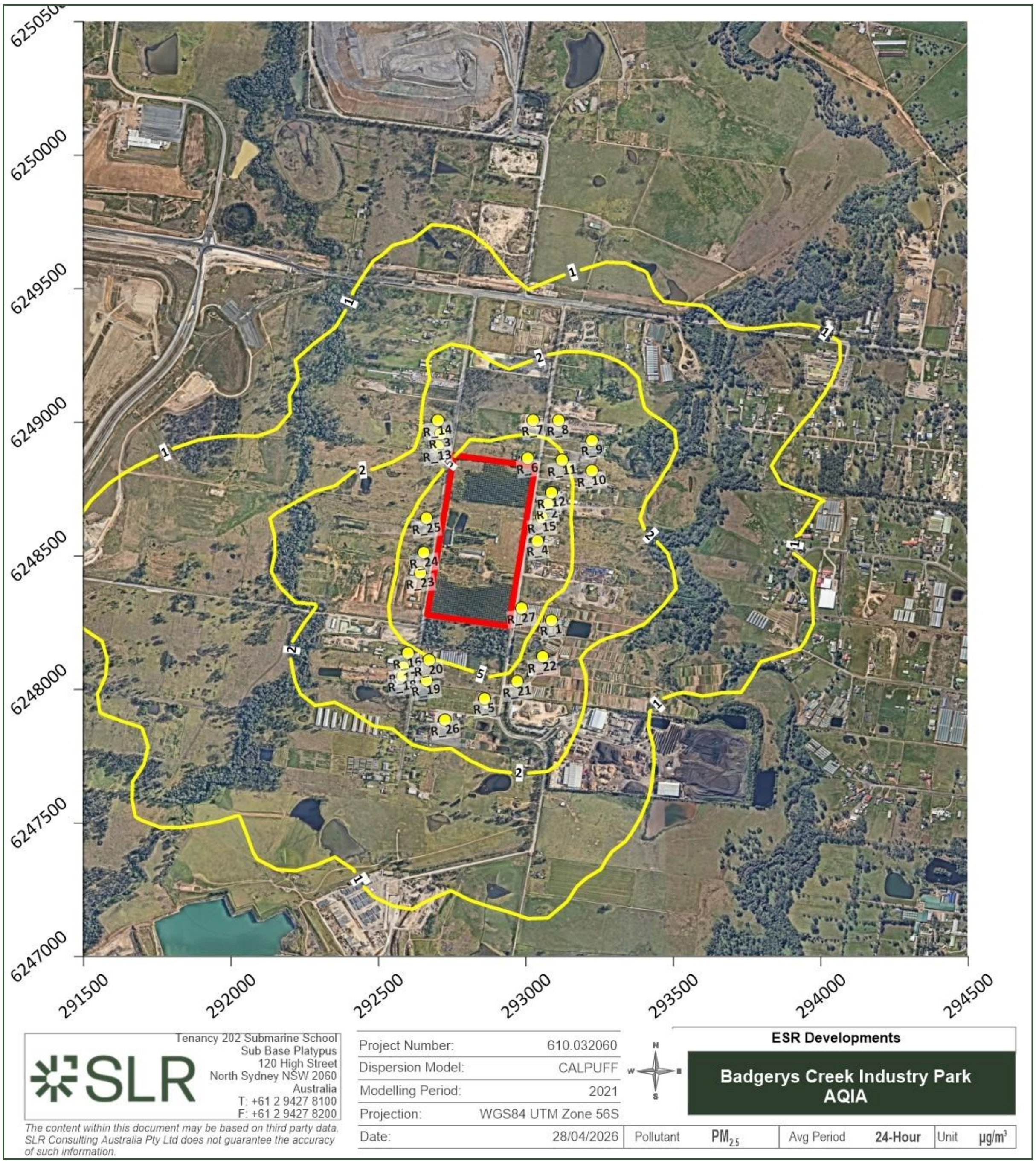


Figure E-2 Annual Average Incremental Impacts of $PM_{2.5}$

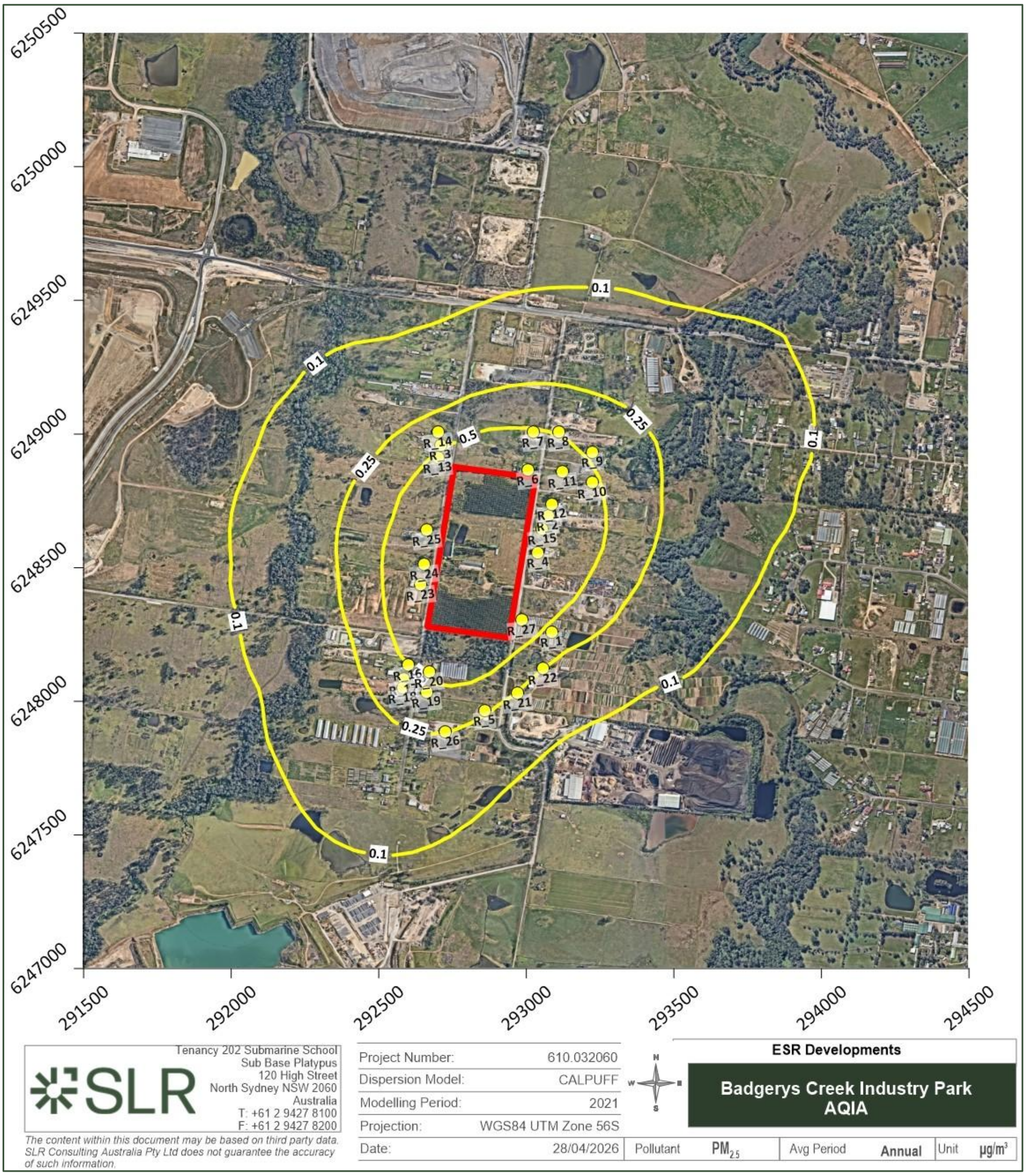


Figure E-3 24-hour Average Incremental Impacts of PM_{10}

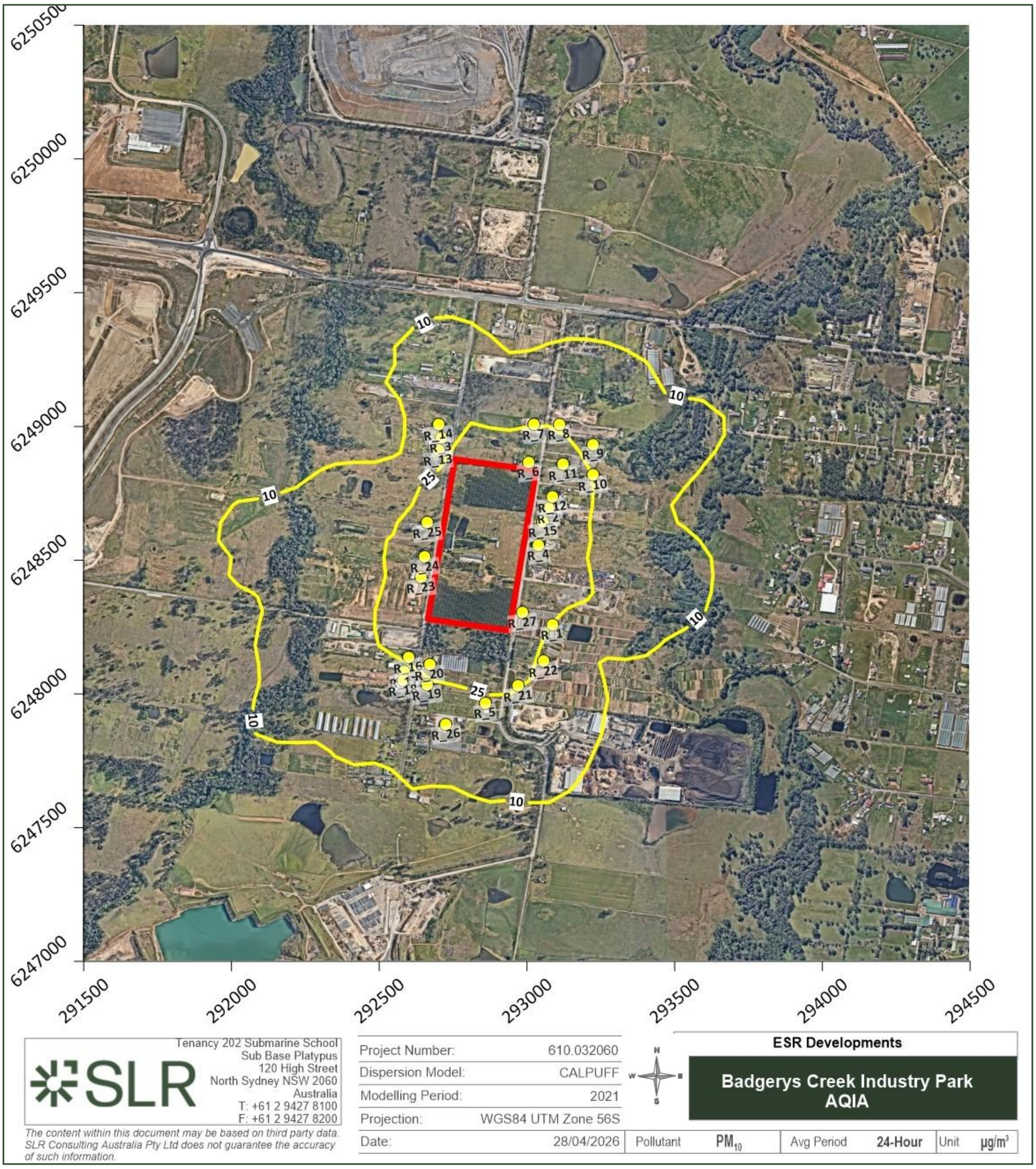


Figure E-4 Annual Average Incremental Impacts of PM_{10}

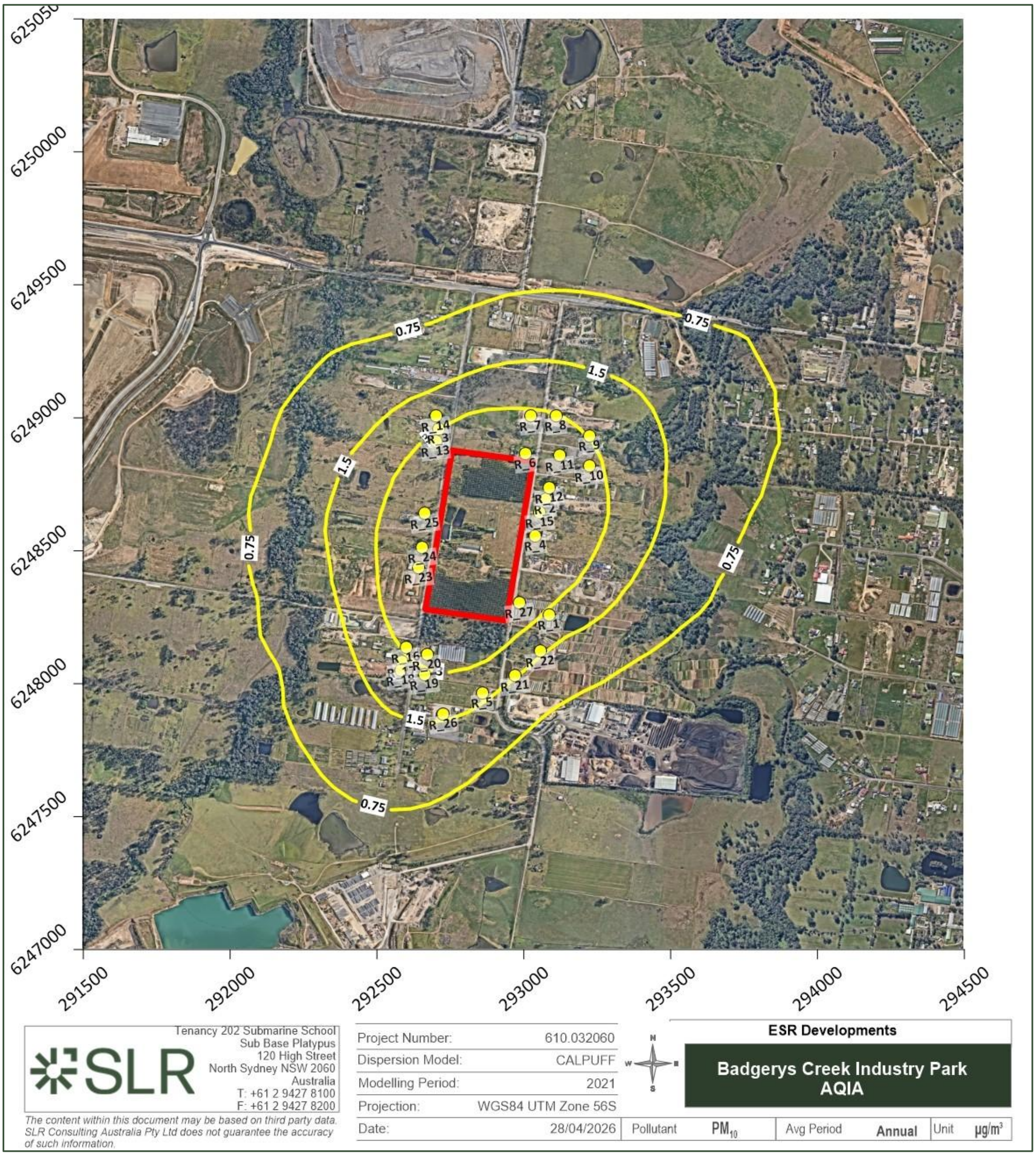


Figure E-5 Annual Average Incremental Impacts of TSP

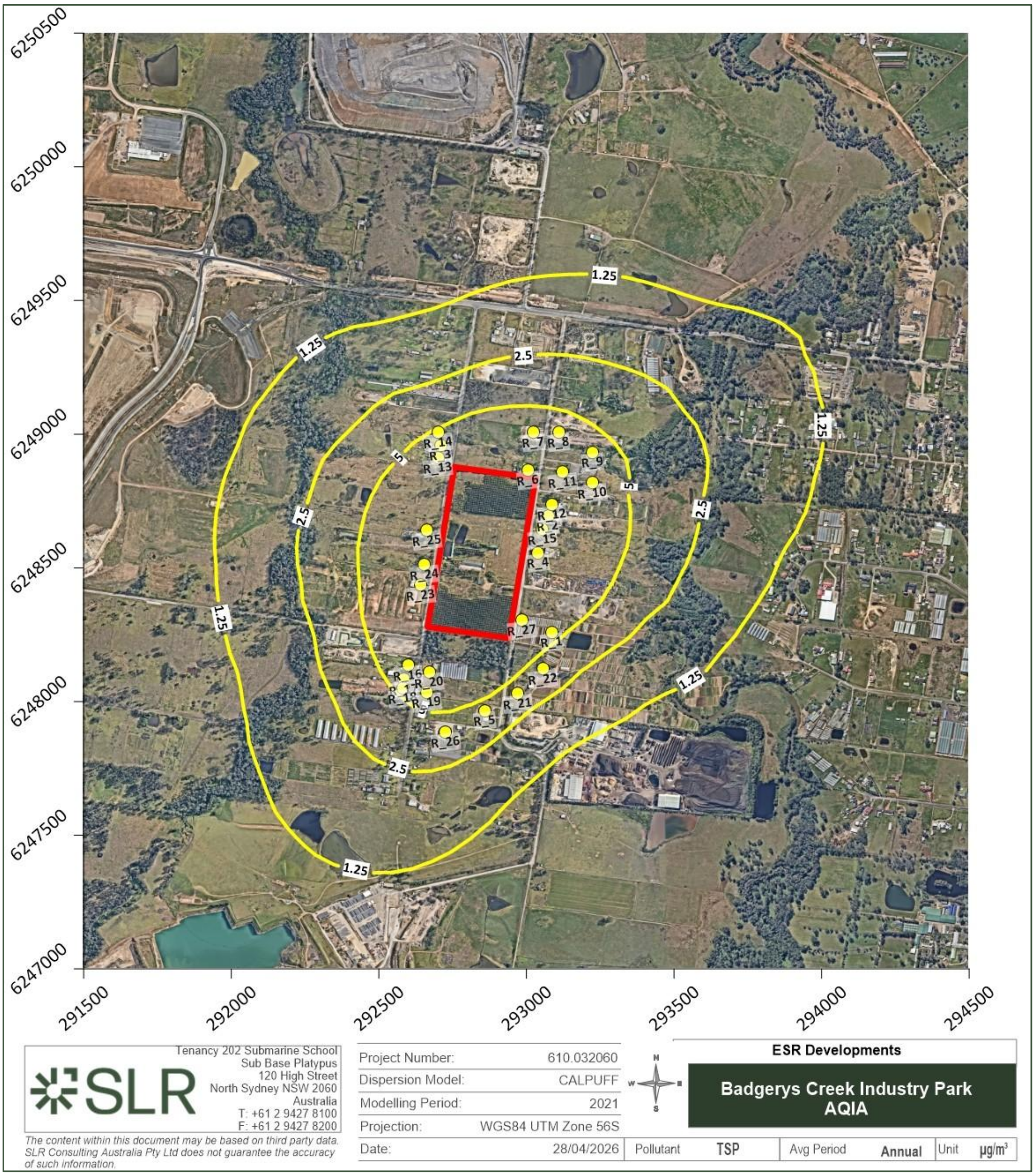
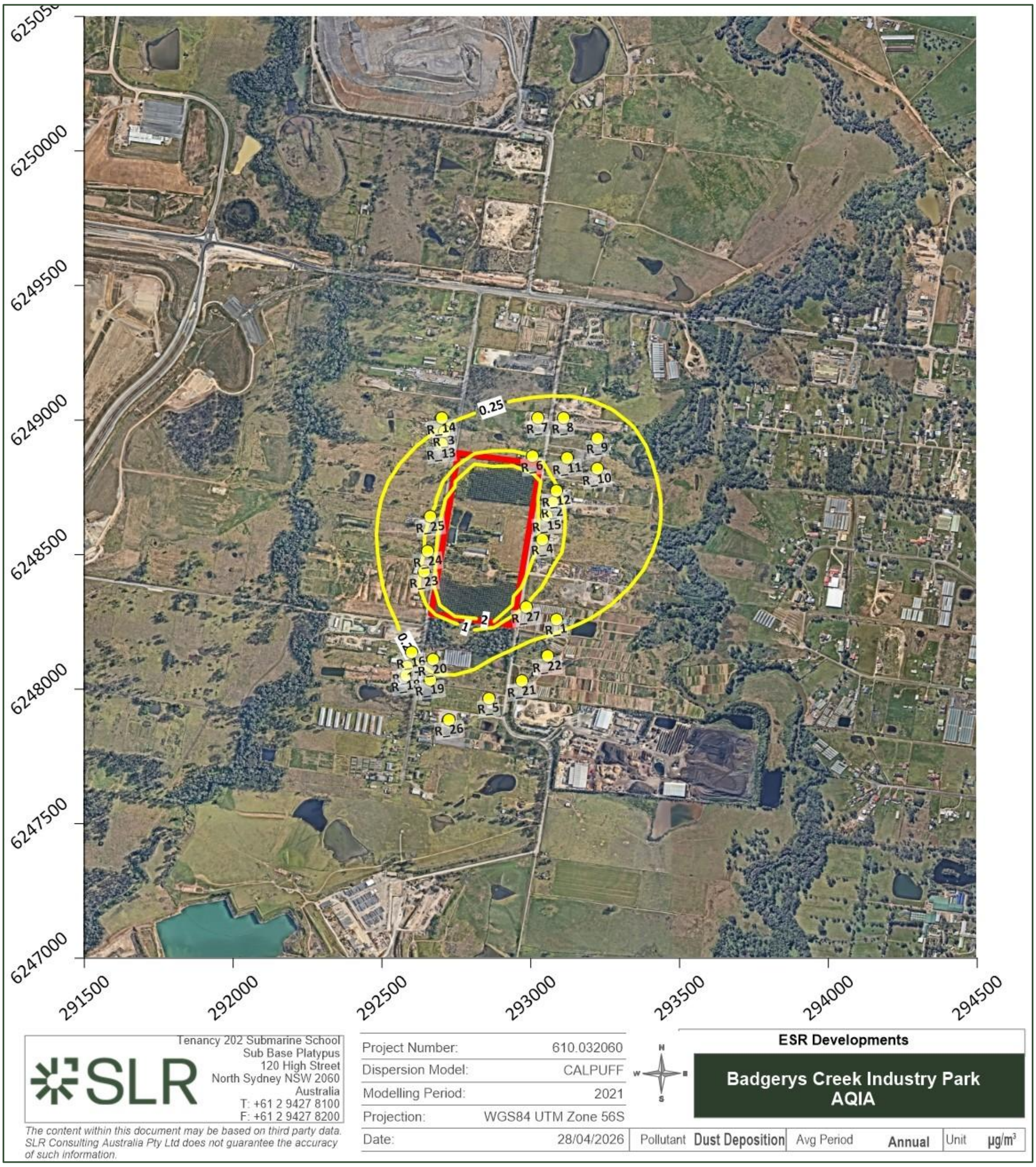


Figure E-6 Annual Average Incremental Impacts of Dust Deposition



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